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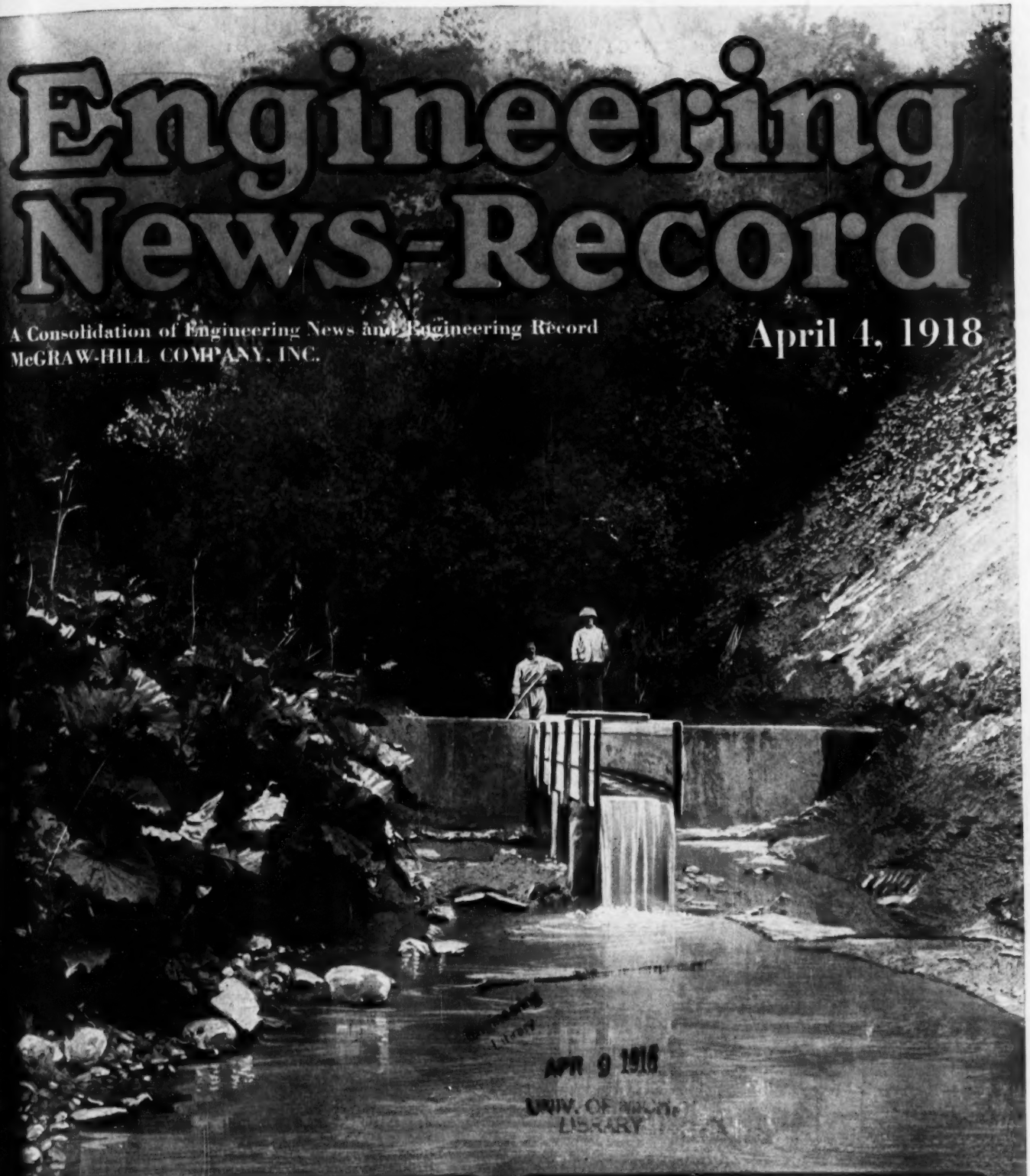

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THIS glimpse of the quiet engineering work of stream surveying in far off Crimea scarcely suggests war. Yet our Russian ally, of whose southern border this peninsula forms a part, is already prostrate before the aggression we have taken up arms to check. Look at this photograph—try to visualize what is happening in Russia today—then go to the nearest agency and buy Bonds of the Third Liberty Loan to end this war!

In This Issue

Leakage from Canals and Reservoirs
By A. P. DAVIS

Experiences with Imhoff-Tank Foaming Told by Sewage-Works Operators

Kreolite LUG WOOD Blocks

"The Paving that's Saving"

NASHVILLE had previously laid some plain rectangular creosoted blocks, but after extended investigation, the City Engineer decided that LUG BLOCKS gave a much better foothold for horses—horse and mule traffic is still used on an extensive scale in Nashville and there are many steep grades. Furthermore, it was also found that the LUGS eliminated bulging and "bleeding"—so Nashville, like many another, came to Kreolite Lug Wood Blocks for paving. Write for full data.

"The Lug Makes a Good Block Better"

50% of orders received in 1917 were repeat orders.

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ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN, Editor — CHARLES WHITING BAKER, Consulting Editor

Volume 80 — NEW YORK, THURSDAY, APRIL 4, 1918 — Number 14

First Deficit Easily Explained

REPORTS just given out showing that the first month of Government operation of the railroads resulted in a deficit need not be taken as a condemnation of Government operation. January was the worst month for operation in railroad history—so much worse than other months that there is no basis for comparison. Judgment can therefore be properly reserved until the returns are in for several other months.

Their Last Disguise Stripped Away

BY THE time this issue reaches the reader the occasion which prompted the editorial from which the following quotation is taken will probably have passed into history. Nevertheless, the idea expressed will, unless the decisive blow is dealt to Germany in the great battle raging as this is written, be pertinent for many a day. The New York "Evening Post" of March 26, in its introductory paragraphs on the great battle said:

"The antagonists stand for much more than armies in a gigantic wrestle. It is not merely of the military features that we think—the shock of battle, the putting into play of every enginery of death, the garments rolled in blood—but of the ideas which animate the fighters. Not two nations, not two embattled hosts, but two systems, two ideals of life and government, are fighting a duel to the death. We could endure the defeat of the armies of the Allies, but could we survive the triumph of the conceptions and the methods for which the German war-lords are hazarding the very life of their country? Their last disguise has now been stripped away. We see them as they are—veritable Apollyons bestriding the path along which a peaceful civilization would progress."

The moral is, "Buy Liberty Bonds." Germany has indeed been stripped of her last disguise. The triumph of her ideal would leave no place on this globe for those who believe in the freedom of individuals to develop as they will and to govern themselves.

Water-Treatment Materials Must Have Priority Shipment

THE threatened failure of liquid chlorine deliveries to the water-works of the country because of car priority difficulties must not be repeated. Chlorination of public water-supplies is now so widely used as a safeguard against water-borne typhoid, both for filtered and unfiltered water, that any break in the supply of liquid chlorine is a serious health menace to millions. How nearly some of the largest water-works of the country, as well as many smaller ones, came to being absolutely without liquid chlorine, and the expense to which they were put to get long-distance shipments by express, is hinted at but not fully revealed, by the staff survey published on p. 688 and the report of the convention of the Indiana Sanitary and Water-Supply Association, printed on p. 685. It appears from the latter that the danger was made all the greater by threatened failures of coagulant supplies. If anything is entitled to priority shipment it is material essential to the purification of the water-supplies of our cities. After the priority order for liquid chlorine was secured its value was nullified by the refusal of the carriers to return the empty chlorine cylinders, which are essential to the maintenance of the supply. Why the return of the cylinders was not covered in the original priority order is a pertinent question, but that oversight should be no bar to an immediate amendment or supplement to the original order. Water chlorination is helping win the final battle against water-borne typhoid. Whatever else awaits shipment, it and other water-purification agents must be given right of way.

Unbalanced Bidding Versus Unbalanced Estimates

THE adoption on Mar. 21 at the meeting of the American Highway Association in Boston of resolutions against unbalanced bidding indicates that these gentlemen are still laboring under the misapprehension that unbalanced bidding is the fault of contractors and that it can be remedied by throwing out all unbalanced bids. The discussion over the resolution went back nine or ten years to the days when quantities which were known to be 300 or 400 per cent. out of the way were advertised by engineers for the purpose of comparing bids, and when unbalanced bidding was a flourishing industry. The members of the Massachusetts Highway Association entirely overlooked the fact that unbalanced bidding of this sort cannot possibly be made profitable unless the bidder knows that the quantities which the engineer has put forth as a basis for comparing bids are incorrect. The contractor may gain this knowledge in two ways. Either the contractor and the engineer may both be dishonest, and the contractor may thus be informed that the quantities advanced are for the purpose of concealing the nature of the work from the other bidders for his exclusive benefit, or the engineer may actually have made mistakes in the estimate which the contractor has checked

up and discovered. In either case, the engineer is just as bad as the contractor. It seems a little unusual, moreover, to demand that bids in which the same person is interested under different names should be automatically excluded. This would mean that a subcontractor or material supply man having furnished one bidder with a figure would not dare to quote another bidder on the same contract. Such firm might have the lowest cost for material on the local market, at the same time the first firm which he quoted might have estimated the highest labor cost on the entire list of bidders. In this way the city or county would be obliged to pay more for its work than if more efficient bidders had also been able to quote material prices from the same supply firm.

Action Needed on Bill To Relieve New York Contractors

THE strike which is developing on the work of completing the new subway system in New York emphasizes the importance of legislation such as that being considered at Albany to make a readjustment of the contracts possible. There are grounds for the belief that unless this legislation does go into effect, a great deal of confusion and delay on this and other public work must follow.

Although the carpenters, form builders and the laborers who have begun the strike signed an agreement not to demand further wage increases until the completion of the new subway system, it is understood that such demands are the basis of the walkout. When the last agreement granting these men higher wages was made no one foresaw the further great rise in the cost of living and in the wages to be paid on emergency construction work for the Government, which within a short time made the increases granted as unsatisfactory to the men as the original rate of pay.

The United States Government is planning to draw heavily on the New York labor market for construction this year, and contractors have feared that some such development as this would add to the difficulties which already threatened the work at many points unless the construction contracts could be modified to enable the contractors to meet conditions.

It is therefore fortunate that the hearing on the bill designed to enable public bodies to readjust the construction contracts, which is now in committee at Albany, developed little opposition. The hearing, held last Thursday, brought forth the fact that there would be no conflict between this bill and a similar one which was introduced for the benefit of the New York State Highway Department and will soon become a law. Two modifications were proposed by the Public Service Commission for the First District, which has charge of the subway contracts. This commission executed the contracts in the first place, and under the bill it would have the sole responsibility of readjusting them. It is desired that the Board of Estimate of New York City, which is furnishing the money for the subway construction, should be made a party to the readjustment. While, as reported on page 531 of *Engineering News-Record* for March 14, the bill sponsored by the contractors makes it optional whether its provisions shall be applied to any particular contract, once the choice to take advantage of the act has been made the procedure is fixed. The second change suggested by the Public Service Commission was to make the procedure of applying the act to any particular contract indeterminate.

The exact nature of the changes which the representatives of the commission had in mind are not available, as the legislative committee requested that they be submitted in writing. However, it appears that the original form of the bill outlines the better method. When all of the contracts on which the parties take advantage of the act must be adjusted in the same way, there is less chance for dispute. When the act comes to be applied the present form would probably be found more workable.

It is to be hoped that the legislature will enact the measure making it possible to readjust these public contracts at the present session. The fact that it is not economical in the long run to make the contractor assume all of the risks was never better illustrated. The passage of the present bill, giving legal recognition to this fact, will pave the way for changes in public contract forms which will make this kind of contracting less of a gamble, and consequently enable states and cities to construct public works with greater econmy.

National Labor Policy Recommended

THE War Labor Policy Board has reported. The representatives of the employers, the workers and the public all signed recommendations to the Secretary of Labor. Fortunately, there is no minority report.

The document is based on a recognition by all parties that *production* will win the war. It aims principally at the prevention of both strikes and lockouts, but in a statement of principles condemns measures which restrict output, provides for the mobilization of labor, and recognizes the necessity of dilution by women workers—all indicating that the way is being cleared to put our industries unrestrictedly back of the fighting forces.

Nothing is said in the report to give the workers assurance that profiteering will be made impossible. The subject must have come up in the deliberations, and a statement of the reason for its omission would not only be interesting but throw light on the attitude of the labor representatives. If the omission be construed as an indication that the belief among the workers that there is profiteering by the employers no longer prevails—and one recalls the emphasis the Secretary of Labor placed on this matter at Atlantic City last fall—we may well feel gratified. As long as it continued (or continues, for we believe it is not entirely dead), no amount of machinery, however highly endorsed, would be of much avail to secure the tremendous production on which the winning of the war is dependent. If, however, the belief still persists it will crop up immediately in the settlement of disputes under the machinery recommended and will therefore come in for quick attention and force the necessary steps to assure the workers that no individual or individuals shall profit unduly by their increased efforts.

The actual machinery recommended for the settlement of disputes need not be gone into here. It calls for

the establishment of a National War Labor Board, with various machinery of conciliation, and is unusual only in that in case of failure on the part of employers and workers to agree the verdict of a single umpire will be final.

The principles which are to govern the National War Labor Board represent the real constructive work accomplished. The employers recognize the right of the workers to organize in trade unions and to bargain collectively, agree that men should not be discharged for legitimate trade union activity, that union standards as to wages, hours and other conditions shall be maintained in shops where now established; that existing safeguards and regulations for the protection of the health and the safety of the workers shall not be relaxed and that in the establishment of wages the minimum shall be that upon which the worker can support himself and his family in health and reasonable comfort.

The workers, on their part, admit that coercive measures are not to be used, and assent to the three propositions mentioned in the second paragraph of this editorial—abrogation of restrictions of output, provision for the mobilization of labor, and recognition of the necessity of dilution by the use of women workers.

In the matter of open shops there is give and take, the worker agreeing that the continuance of such conditions shall not be deemed a grievance, and the employer conceding that the war condition shall not be used to prevent the progressive improvement of condition of labor in the shop. This, to our mind, constitutes the most progressive feature of the report. Labor leaders have expressed the fear that the war would be taken as an excuse for continuing conditions which were really intolerable.

On the matter of women labor there is likewise give and take, for while the employes admit that they should be employed, the employers declare it as their faith that there should be equal pay for equal work.

The report, it will be seen, compromises the major difficulties between employer and employe. How successful the remedy proposed will be can be determined only by practice. Certainly there is secured the great benefit of a very free and full discussion of differences between employer and worker, resulting in a compromise that receives unanimous approval. The basis from which the National War Labor Board will start, therefore, is a good one. If its attitude and those of the conciliatory boards which will operate under its jurisdiction is prompted by an eye single to the best interests of the nation, we should not only have industrial peace during the period of the war, but have established such a good relationship between employer and worker that they will be able to build upon this better feeling a peace-time structure far better for all concerned—the owner, the worker and the public—than obtained before the war. In other words, it is one of the rewards for the terrible orgy of bloodshed into which the German lust for power has plunged us.

We do not hail the report, of course, as the ultimate solution of our industrial labor problem. It is, however, a step in the right direction. Employers unconciliatory in the past toward the demands or aspirations of the workers will, through such coöperation as shall be established, be prepared for intelligent employment management methods and for the sort of industrial democracy which the Rockefeller interests introduced successfully into the workings of the plant and mines of the Colorado Fuel & Iron Co. and which last week, they announced, were to be installed at the Bayonne plant of the Standard Oil Company.

Whatever improves the relationship between the employer and the worker prepares a solid base upon which industrial improvement may proceed.

Standard Oil's Labor Policy at Bayonne

WHEN the workers at the Bayonne plant of the Standard Oil Company of New Jersey elected 73 representatives from among themselves to treat with their employers on questions of wages, working conditions and similar matters, the step was taken at the company's suggestion. Over 93 per cent. of the 8000 laborers participated in the voting—which is rather an indication that the idea was agreeable to the men. No doubt a success similar to that which resulted from the introduction of somewhat the same plan in the Colorado Fuel & Iron Company, following the trouble of 1914, will attend this recognition of labor by the Rockefeller interests.

It is a move in the right direction, a definite step toward the greater efficiency that will inevitably follow a realization on the part of capital that labor will yield its maximum of effort only when it is conceded a right to be heard in matters in which it is vitally interested. This right the Standard Oil Company admits when it proposes to treat with the representatives whom labor has itself elected, on such points as wages and conditions of work. A universal acceptance of this principle would go a long way in solving the day's labor instability.

And it must not be forgotten, though in some reactionary quarters it is still denied, that a contented workman can coax from his tools a quantity of finished goods which is surprisingly greater than that now expected under average circumstances. It is this desire to do the utmost that we must instill into labor, for even the most casual analysis should reveal the fact that the tool power of the country would be more than doubled if each lathe and loom could be so handled that it would produce twice as much.

No matter how often it has been said that this war is a war of tool power, it will bear repeating. Could we save the energy that is now consumed in making more tools—using tools in the sense that they are the machines which produce munitions—and apply this energy to the making of munitions, it would not be long until we would overcome the advantage that Germany possesses because of her ability to command obedience. A free laborer is worth many slaves, and if we could make American labor really believe that it is free labor, the slackness of interest which characterizes it now would disappear, and in its place would be born a spirit before which the artificial and unstable advantage of our enemy would vanish as smoke before the breeze. May there be many more firms who, for no matter what reason, will take a look ahead and follow the lead of the Standard Oil Company of New Jersey.

Brick Chimney of Record Height Built To Carry Off Smelter Gases

One Foot Higher Than Concrete Stack at Saganoseki—Proportioned To Resist Wind Pressure of 78 Lb. per Sq.Ft.—Foundation Problem Solved by Extending Footing Down to Hard Clay—Water Diverted by Cutoff

By Charles Evan Fowler
Consulting Engineer, New York

THE new stack of the Tacoma Smelting Co. at Tacoma, Wash., exceeds all previous height records for chimneys. It rises 571 ft. above top of footing (just above ground level) and 601 ft. above foundation level. As it stands on a ridge about 150 ft. high, its top is 725 ft. above tidewater, only a few hundred feet away.

Thirteen years ago the company built a reinforced-concrete chimney 300 ft. high and 21 ft. in diameter (described in *Engineering News*, Aug. 3, 1905, p. 120), to carry off the fumes from its smelter. This chimney, standing on a hogback or ridge behind the smelter, was expected to carry the smelter gases to such a height that no nuisance would be created in the neighborhood. However, partly because of the rapid growth of the city, complaint soon arose concerning the effects of the fumes, and this resulted in the decision to build another chimney several hundred feet higher. The new stack, built of brick, was completed last November. It is located on the same ridge as the old one and not far from it, as Fig. 1 shows.

In contracting for the new chimney the smelting company undertook to construct the foundation, ready for the brickwork. Uncertain soil conditions found in the first excavation produced an interesting problem, briefly described in the following.

The excavation was first carried about 8 ft. below the original surface, or to an elevation of 144.4 ft. above sea level. This work disclosed a bed of compact sand. An octagonal reinforced-concrete base was designed, to distribute the load upon this sand. Its diameter was 103 ft. and its thickness 20 ft., the diameter of the chimney base being 50 ft. 2 in., as shown in Fig. 2; reinforcement of 60-lb. steel rails was to be embedded in it. The calculations for foundation pressures were originally based on a wind pressure of 30 lb. per sq.ft. of projected area of the chimney, corresponding to a wind velocity of about 100 mi. per hour, and showed a maximum pressure on the sand of 3.25 tons per square foot.

After the reinforcing rails had been placed, ready for the pouring of the foundation concrete, water was encountered in a pit dug at one side of the foundation, at a depth of about 4 ft. below the base. The writer was called in at this stage to pass on the proposed construction.

From an examination of one or two borings and test pits, and near-by cuts and bluffs, it developed that the hard blue clay or hardpan underlying the surface sand was at a variable depth. More borings were made. They showed the hardpan at the chimney to lie from 9 ft. to 30 ft. below the sand footing already prepared.

The decision was first made to dig a cut-off trench from side to side of the hogback, down to the hardpan, to cut off the groundwater flow. This trench was dug to a final length of about 150 ft. A thin concrete wall, with hydrate of lime in the mixture as waterproofing, was built in it, and the trench backfilled with the hard clay.

As to the foundation itself, three courses were open: First, to risk the uneven settlement on the varying thickness of sand, after its drainage; second, to drive concrete piles down to hardpan; third, to carry the footing excavation down to the hardpan. The latter could be done by going to a depth of 30 ft., as at this level the clay would be reached over practically the full area. This third course was adopted. As shown in Fig. 2, the foundation was carried down to El. 123.9, except for a small segment along one edge where a separate footing was carried down in steps 12 ft. deeper. The reinforced base as shown in Fig. 2 was designed by R. Bergerson, chief engineer of the Tacoma Smelting Company.

The final dimensions of the work are as given in Fig. 2. The height of 571 ft. from top of footing to chim-

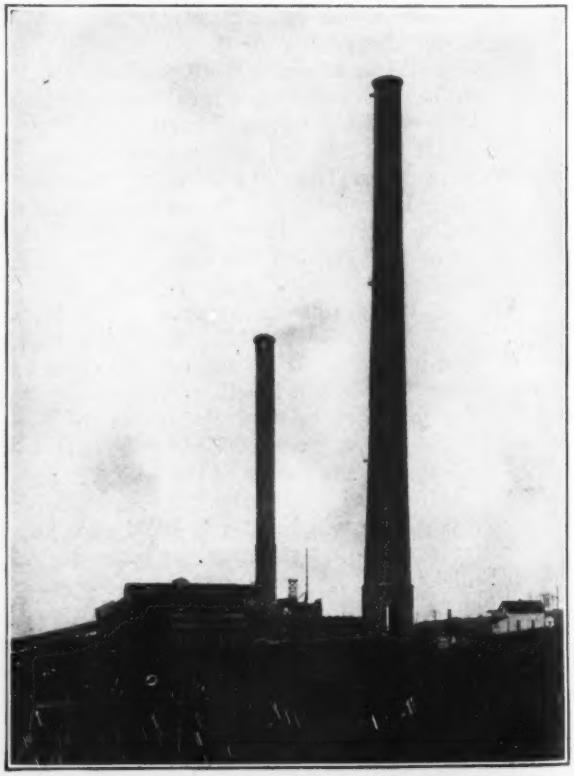


FIG. 1. NEW BRICK CHIMNEY DISCHARGES SMELTER GASES AT NEARLY TWICE THE HEIGHT OF THE OLD

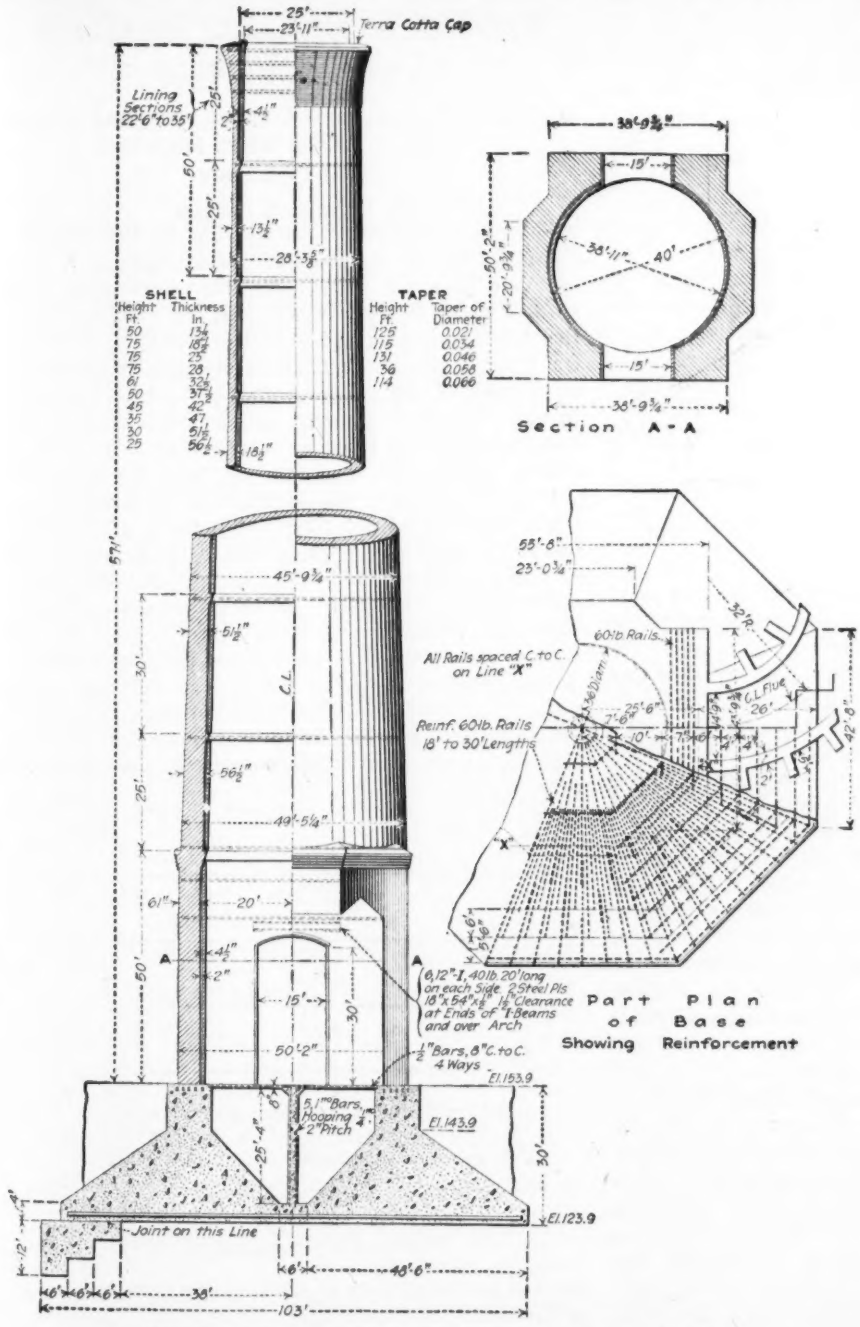

Terra Cotta Cap
Lining Sections 22'6" to 35'
SHELL
Height Ft. | Thickness In.
50 | 13¼
75 | 18½
75 | 23
75 | 28
61 | 32½
50 | 37⅝
45 | 42
35 | 47
30 | 51½
25 | 56½
TAPER
Height Ft. | Taper of Diameter
125 | 0.021
115 | 0.034
131 | 0.046
36 | 0.058
114 | 0.066
Section A-A
All Rails spaced C. to C. on Line "X"
60 lb. Rails
Reinf. 60 lb. Rails 18' to 30' Lengths
Part Plan of Base Showing Reinforcement
6-12"-I, 40 lb. 20' long on each Side, 2 Steel Pls 18"x54"x⅝" ½" Clearance at Ends of "I" Beams and over Arch
1" Bars, 8" C. to C. 4 Ways
El. 153.9
El. 143.9
El. 123.9
Joint on this Line
571'
103'

FIG. 2. BASE AND SHELL DETAILS OF TACOMA STACK

ney cap makes the Tacoma stack just a foot higher than the Saganoseki (Japan) chimney described in *Engineering News-Record* of Apr. 12, 1917, p. 100, hitherto the highest in the world. The brick shell ranges in thickness from 5 ft. 1 in. at the base and 4 ft. 8½ in. just above the base, to 13½ in. just below the bell at the top. Throughout the height of the stack there is a 4-in. firebrick sectional lining, separated from the shell brickwork by a 2-in. air space.

The final determination of the bearing pressures on the clay foundation was arrived at by using a wind velocity of 125 mi. per hour. There are records of 90-mi. winds off the northwest coast, and it seemed advisable, for such an unprecedented structure, to make allowance for gusts of wind of high velocity and for possible vibration effects. A pressure of 78 lb. per square foot on a flat surface was calculated as equivalent to this wind velocity, and 0.6 of the projected area of the circular shaft was taken as effective normal surface.

Permissible soil pressure was determined by the writer's modification of the Antwerp formula, as representing the most scientific basis yet proposed for fixing soil resistance (see "Subaqueous Foundations," John Wiley & Sons). The formula is

$$p = 0.68a + 0.014\,ah$$

where $a = 3$ tons per square foot for moist sand, or 5 tons per square foot for hard clay; h = depth of foundation bed in feet; and p = allowable soil pressure in tons per square foot. The formula gives as the permissible pressure on moist sand at 30-ft. depth 3.30 tons per square foot, and on hard clay at the same depth 5.50 tons per square foot. On account of the presence of water it was not thought advisable to make a higher allowance for the clay as hardpan.

The computed maximum base pressure from the assumed wind, in combination with the weight of the stack, is 5.01 tons per square foot, assuming the added weight of the deeper concrete base to be 1 ton per square foot.

Another feature requiring serious consideration in fixing on the foundation design was an old clay pit only 200 ft. away from the site of the stack, with a drop-off of 110 ft. (see section in Fig. 3). The writer's report dealt with this matter as follows:

"The records as to angle of repose of wet clay show that the only safe figure to adopt is 26°. The drainage down the gulch to the east makes it evident that sooner or later there will be a break at about the point marked X (Fig. 3), which would make the slope from the original elevation of the footing to the bottom of the clay pit about 33½° instead of 27½°. With the footing

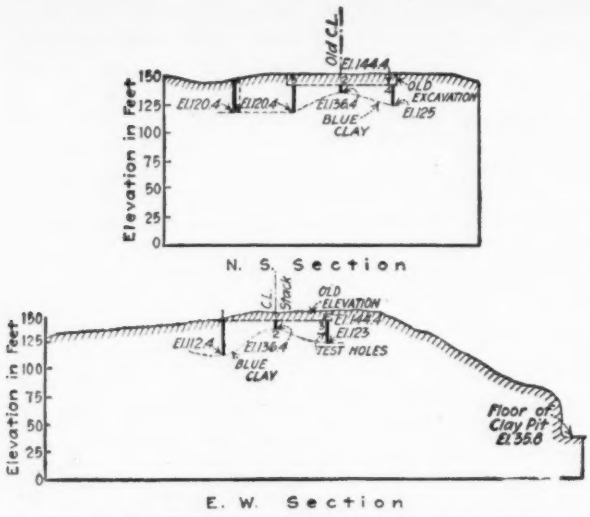


FIG. 3. SUBSOIL AT SITE OF STACK WAS SAND OVERLYING UNEVEN CLAY SURFACE

lowered to at least El. 124, the slope would be 28°, and every foot additional it is lowered and also moved to the west will improve matters greatly."

The foundation was being moved away from the clay pit and carried to the depth recommended, El. 124 ft. The cut-off wall was put in to prevent the water from springs getting to the foundation, and everything humanly possible was carried out to prevent future troubles. Similar soil in the northwest has been found to be very treacherous.

The writer is indebted to H. Y. Walker, manager at Tacoma for the American Smelting and Refining Co., for many courtesies and for authorization to publish the results of the foundation studies; to R. Bergerson, chief engineer, for coöperation and the use of data; and, finally, to the builders of the chimney, the Alphons Custodis Chimney Construction Co., New York City, for drawings and photographs.

Meters Measure Half of Detroit Water Supply

Of the water furnished to the 861,427 persons in Detroit in 1917, 56.7% passed through meters and produced 66.3% of the revenue. Meters increased in number from 46,991 in 1916 to 65,542 in 1917. The daily average consumed was 165 gal. with the maximum hourly rate 55% above the average on July 26. Industrial consumption is estimated at 35% of the total. The Fire Department estimates that it used one-seventeenth of one per cent.

The pumping stations showed an average station duty of 99,600,000 ft.-lb. per 100 lb. of coal, an average of 953 gal. pumped per pound of coal. Costs per million gallons raised 100 ft. are as follows: Labor, $1.26; fuel, $1.36; oil and supplies 0.06c. and miscellaneous, 0.10c.

Treating the water with 2 lb. of chlorine per million gallons at a cost of 40c. reduced the bacteria per cubic centimeter on agar at 37 deg. C. from 27 to 7. In the raw water B.coli were confirmed in 63 out of 589 samples of 1 c.c. and 866 out of 2945 samples of 10 c.c. In the treated water only 16 out of 2945 samples of 10 c.c. were confirmed and no positive indication was found in any of 589 tests of 1 c.c. samples.

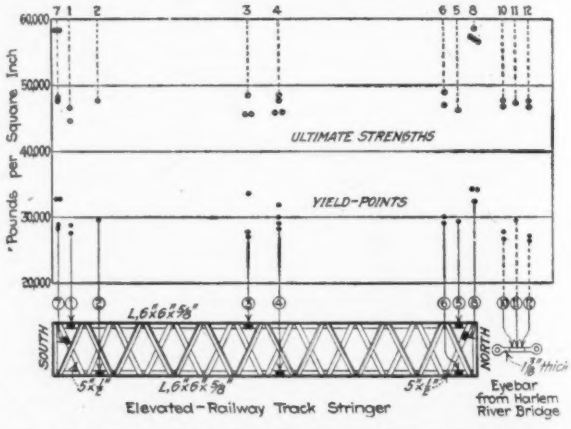
Iron Not Weakened by Service in Elevated Railway

Good Test Results from Wrought Iron That Carried Hundred Million Wheel Loads in Thirty-Five Years

By George H. Pegram
Chief Engineer, Interborough Rapid Transit Co., New York City

THE west-side elevated railroad in Manhattan, New York City, has been in continuous operation since 1879. Except for certain additions and reinforcements the structure is the same as that originally constructed. On account of the Manhattan elevated improvement work some of the old track stringers which had been in use since the beginning, and probably during that time subjected to stresses produced by one hundred million wheel loads, were removed from the structure.

In order to get some idea as to the condition of the iron of which these girders were made, after thirty-five years, test-pieces were cut out of the flanges of one of the girders removed, a lattice girder with flanges made up of two angles. These test-pieces were subjected to tensile test by Prof. Frederick L. Pryor of Stevens Institute of Technology, and gave the following results: yield-point 27,040 to 33,670 lb. per sq.in., ultimate strength 44,770 to 49,090 lb. per sq.in., elongation (per cent. in 8 in.) 8.63 to 15.38. These figures represent the results from fifteen test-pieces taken from the



TESTS SHOW NO DETERIORATION OF OLD ELEVATED RAILWAY STRUCTURES

top and bottom flanges of the stringer at the ends and at the center of the stringer.

Some years ago the stringer was double-latticed with flat steel bars. These flat bars show a yield-point of 28,610 to 34,620 lb. per sq.in., an ultimate strength of 48,070 to 58,680 lb. per sq.in., and an elongation of 22.5 to 33.39 per cent.

At the same time that this girder was removed from the structure the old Harlem River bridge which was erected in 1886 was also removed and pieces cut from eyebars taken from the bridge were tested. Five test-pieces showed a yield-point of 26,570 to 29,540 lb. per sq.in., an ultimate strength of 46,990 to 47,860 lb. per sq.in., and an elongation of 16.88 to 37 per cent.

A record of the tests is given in table herewith, and diagram shows yield-points and ultimate strengths.

Test-pieces 1 to 6 are from the top and bottom flanges of the original iron girder, 3 and 4 being from the middle of the flange, where the maximum stresses occur in service, and where service deterioration might be expected to appear first. No differences are perceptible between the results of tests 3 and 4 and those of 1, 2, 5 and 6. Test-pieces 7 and 8 are from the flat steel lattice bars added to the girder later, and test-pieces 10 to 12 from the eyebars of the Harlem River bridge.

There is no record of any tests of the material at the time the structures were built. The results of the test would indicate that no deterioration of the material has taken place during the many years of use.

TENSION TESTS OF WROUGHT IRON AND STEEL FROM OLD STRUCTURES OF MANHATTAN ELEVATED RAILWAYS

Piece No.		Original Dimensions Breadth, In.	Thickness, In.	Area, Sq.In.	Elongation, Per Cent. (Over 8 In.)	Yield-Point Actual, Lb.	Yield-Point Lb. per Sq.In.	Ult. Strength Actual, Lb.	Ult. Strength Lb. per Sq.In.
1	From ends	1.496	0.542	0.8108	8.63	23,440	28,790	37,870	46,710
1	of stringer	1.507	0.571	0.8605	15.00	23,650	27,480	38,520	44,770
2	flange	1.514	0.587	0.8887	10.75	26,260	29,550	42,520	47,850
3		1.512	0.603	0.9117	10.13	24,640	27,040	41,710	45,750
3		1.516	0.582	0.8823	11.37	29,710	33,670	42,910	48,640
3	From middle	1.506	0.600	0.9036	12.91	24,950	27,610	41,350	45,760
4	of stringer	1.501	0.571	0.8571	18.63	25,720	30,010	41,100	47,960
4	flange	1.502	0.574	0.8621	11.88	27,500	31,900	41,910	48,620
4		1.508	0.566	0.8535	11.88	24,100	28,240	39,475	46,250
4		1.503	0.570	0.8567	11.27	24,840	29,000	39,400	45,990
5	From ends	1.512	0.570	0.8618	14.38	25,350	29,410	39,900	46,300
6	of stringer	1.500	0.577	0.8655	15.38	25,150	29,060	40,810	47,150
6	flange	1.514	0.576	0.8721	15.25	26,230	30,080	42,800	49,080
7		1.510	0.462	0.7429	33.39	21,250	28,610	35,710	48,070
7	From added	1.507	0.486	0.7324	22.50	24,040	32,810	42,640	58,210
7	steel	1.501	0.490	0.7355	29.75	21,200	28,820	35,450	48,200
7	lattice	1.510	0.493	0.7444	27.38	24,550	32,980	43,470	58,380
8	bars of	1.519	0.470	0.7139	22.50	24,500	34,320	41,890	58,680
8	track stringer	1.512	0.491	0.7424	26.39	25,700	34,620	42,600	57,380
8		1.522	0.488	0.7427	24.12	24,100	32,450	42,390	57,080
8		1.517	0.492	0.7464	26.51	25,720	34,460	42,400	56,800
10	From	1.396	1.496	2.0884	23.25	55,820	26,730	98,340	47,090
10	eyebars of	1.499	1.391	2.0850	18.75	57,880	27,760	99,790	47,860
11	Harlem	1.513	1.363	2.0622	*	64,800	31,420	*	*
11	River	1.523	1.361	2.0732	37.00	61,250	29,540	98,810	47,670
12	bridge	1.510	1.393	2.1030	26.75	55,870	26,570	98,810	46,990
12		1.503	1.301	2.0907	16.88	56,820	27,180	100,000	47,835

* Specimen withstood 100,000 lb., capacity limit of testing machine.

Snow Plow on Motor Truck Bucks Four-Foot Drifts

Mold Board Constructed of 2x4s Surfaced with Twenty-Gage Sheet-Steel—Spreader at Rear Levels Ridges

By F. P. Stott
Kalispell, Mont.

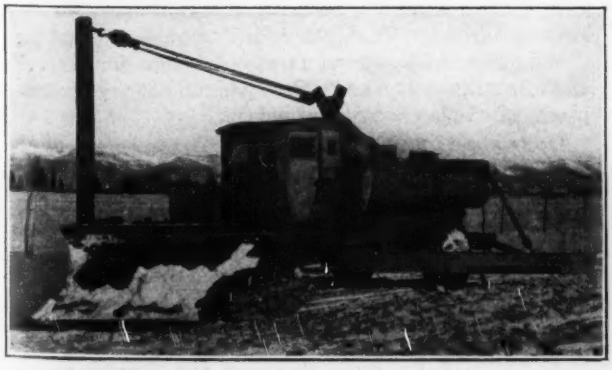
SNOW plows mounted on motor trucks are finding such universal application in these days when commerce is demanding that the roads be kept continually open, that the design adopted and used during the past winter by Flathead County, Mont., is worthy of description inasmuch as the expectation of the engineers was more than met by its performance. I am of the opinion that the equipment developed for this work is superior in design and can be used to better advantage than that described on p. 408 of *Engineering News-Record*, issue of Feb. 28.

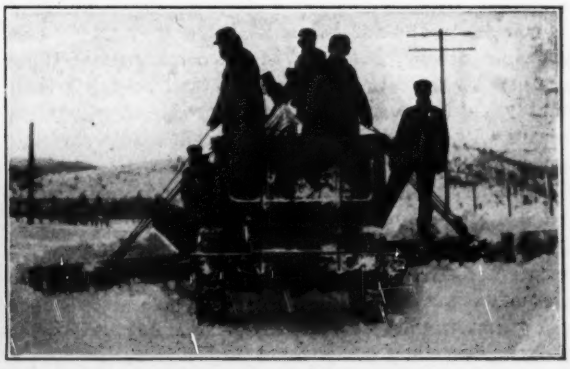
The plow itself is constructed on a frame built of 6 x 8-in. timbers which carries a mould board built of 2 x 4s surfaced with 20-gage sheet steel. The lower or cutting edge of the mould board is armored with grader-blades, and the extreme forward point is protected by a sheet of ¼-in. steel cut and bent to fit. As may be seen from the photographs, the plow may be raised as a unit by means of the block and tackle fastened to an A-frame mounted in the body of the truck.

Spreader boards are attached near the rear of the truck on either side, being raised and lowered by means of block and tackle, as shown in the illustrations. These are not used on the first trip of the plow, but are lowered on the return trip and serve to push back the ridge of snow thrown up by the plow itself. On the return trip, also, turnouts are made by simply swerving the truck to one side. Though not shown in the illustrations, the county has a grader-blade attachment which may be used in place of the spreader board, and it is felt that by operating two trucks—one equipped with spreader boards and one with the grader attachment—the roads could be cleared to any desired width.

The truck itself is rated at five tons. The front wheels are equipped with a convex steel shoe, the rear wheels being provided with cleats made of ¼ x 5-in. strap iron, bent to the shape of the tire and bolted under the rim with ⅝-in. bolts. These cleats are turned up on the advancing edge and have proved more satisfactory than chains, since they furnish better traction and reduce to a minimum the tendency to skid. The cleats were made 5 in. wide, since it was found from experience that a narrower strap had a tendency to crawl and shear the fastening bolts.

This equipment was designed and built to keep only a few miles of main road open for auto traffic, but it proved so satisfactory that it has been used on upward of 90 miles of road, having been found sturdy and powerful enough to buck drifts 4 ft. deep that were crusted hard enough to support the weight of a man. In all of this work the roads were opened for a width of 8 feet.





PLOW IS HINGED TO TRUCK AND ADJUSTED BY BLOCK AND TACKLE FROM A-FRAME

The Engineer as a Social Force in the New Democracy

Conclusion of Presidential Address of Prof. George C. Whipple, Harvard University, Before the Boston Society of Civil Engineers, Deals With Matters of a More Definite Engineering Character Than the First Part, Which Appeared on pp. 599 to 601, Engineering News-Record, March 28, 1918, and Discussed the Relations Between Capital and Labor

THE unmistakable drift toward the adoption of the so-called socialistic program, whether it be permanent or not, seems likely to place engineering work more and more in the public service. The engineers of the next generation will be employed more and more by the nation, the state and the municipality, and their functions will increase greatly in the direction of executive work.

More Engineers in Public Service

At the present time we have some anomalous situations. Public-service commissions, state boards of health, and similar organizations are called upon to advise, to approve plans and to otherwise pass judgment on the designs and proposed work of engineers acting independently or employed by private capital. The salaries paid to engineers employed in the public service are in general lower than the earnings of engineers in private practice. The positions are often filled by young men—usually able, but nevertheless inexperienced. Not infrequently it falls to the lot of these men to pass judgment on plans prepared by other engineers who are far more competent and broadminded than they themselves, and decisions humiliating to the private engineer and unfortunate to the state are liable to result. The obvious remedy for this condition is so to adjust the rewards of public service that the ablest and most experienced engineers will be attracted to it. These rewards must be expressed in reasonable salaries, but also, and what is perhaps more important, in respect and security of office.

During the last few years the so-called "city manager" plan of municipal administration has rapidly come to the front. This is distinctly a recognition of the engineer. A very large percentage of the city managers thus far chosen comprises men from the ranks of our profession.

After the war many of the engineers who have entered the army and navy will doubtless remain in the service. Many engineers of great ability have, from motives of patriotism, accepted emergency government positions for compensations far below anything they would consider in ordinary times. If in the coming peace times they can be made to feel that they will be doing their country a great service and one for which their fellow citizens will give them honor, they will gladly continue in the public service. Certainly there are elements besides monetary considerations which control the acceptance of government positions by engineers.

One result of the entrance of the engineer into public executive life, if such reforms as the initiative and referendum prevail, will be a demand that he display a quality not usually conspicuous among engineers—the ability to describe a complicated project in such a simple and clear statement that the man on the street can understand it. The success of democratic government lies in the intelligent interest which the citizens take in what the officials are doing. More and more, therefore, will it be the business of the engineer to educate the public.

The presence of men belonging to one profession in different branches of the public service ought to bring about a closer coördination of these branches. Governmental departments are of necessity specialized, and of necessity there must be direct lines of authority; but unless there are cross lines, short cuts from one department to another, there is tremendous loss of efficiency and great waste. We have done well doubtless to emphasize the organization chart, but unless we organize the cross lines we shall not have a perfect organism. In all this we can learn much from the organization of the human body. The nervous system and the circulatory system are radically planned, but not every function is controlled by the brain. The human body is full of short cuts, and different parts perform many automatic acts. The body politic should also provide for reflex actions.

Such an organization as that of the New York Society of Municipal Engineers, which brings together engineers from all the various departments where engineers are employed, is an example of coördination in a general way. But there is no intrinsic reason why more specific coördination cannot be made as a part of the regular machinery of government.

Conserve Resources and Use Forces of Nature

Professor Swain has said that the conservation of our resources is a social problem. This being granted, is it not the engineer who must guide the people in their use of these resources? He knows the properties, advantages and cost of different resources, and if he will he can advise their use or disuse, looking not only to the benefit of the job at hand but to the possible exhaustion of the supply. He can often find a way to use natural forces instead of power created by the consumption of resources. It is not without significance that the English engineer Tredgold defined engineering as the "employment of the great *forces* of nature for the use and convenience of man." Tredgold did not say the employment of the *resources* of nature.

If the state becomes the conserver of the resources of the world, the engineer in government employ will be an important factor in guiding the conservation movement. The war has taught us, as nothing else ever did, the importance of our basic productions.

The war is getting the peoples of the world acquainted with each other. It is getting people to think about the resources of the globe in terms of worldwide necessities. It is elevating business, commerce and transportation to a higher plane than they have ever occupied before.

It has emphasized the benefit of organization. The threads of commerce are gradually binding the countries together. Hence the engineer is more and more to find a field for his service abroad.

When one considers Russia and Siberia—with their resources of field, forest and mine—China, Japan, the Philippines, and India, and when one considers also Africa, South America, Mexico, Cuba, and the many tropical islands, it is evident that the resources of the world are very far from being exhausted. More and more must the engineer think in terms of the world. But in doing so the idea of exploitation must forever be renounced. Beneficiency must be practised abroad as well as at home.

The Greatest Hydraulic Problem

The work of engineers in foreign lands will greatly help solve our own problems. Let us take, for example, the control of Chinese floods, the greatest hydraulic problem in the world. If American engineers can help China solve this problem, the problem of the Mississippi will afterward be as child's play. If American sanitary engineers can teach China how to solve her sewage disposal problem and to utilize the fertilizing elements of human beings in a decent manner it may revolutionize sewage disposal in America.

Foreign service is especially attractive to young men. The scattering of young men through the English colonies has been of great benefit to Great Britain. It would be well for us to encourage such service in order to interest our educated and influential young men in governmental work and thus raise the standard of the personnel engaged in such work.

Domestic Engineering

It is not necessary to go abroad to find new fields and new problems. The present war has done much to expand the field. One of the most interesting is the entrance of the engineer into the field of domestic engineering, or, in other words, housing. The health reports of fifty and seventy-five years ago were full of the needs of better housing, and, although a great deal has been accomplished in that time, we are still talking about new building laws and housing laws, and complaining of non-enforcement of regulations. The laws are indeed chaotic and archaic, flawful and awful.

Until recently the engineer has not taken a leading part in providing shelter for the people. House building has been largely an individual matter. But the war has changed all this. Now we see the uncommon sight of engineers constructing houses by hundreds and thousands, building military towns and camps, and organizing companies for wholesale house building. The demand for low-priced houses has become pressing, and the need of temporary houses of laborers at many war plants has been enormous. Engineers and architects are working out details of design and standardizing methods of construction.

In standardizing building construction we can learn much from the Chinese. In China and in Korea a beam is a beam, and a board is a board. Houses are built of beams and boards of standard size. Even ornamental features, such as brackets, etc., are standardized. Beams taken from an old house may be again used in a new house. Scaffolding is used over and over. All this has been from necessity, nevertheless it makes mightily for conservation, and does not produce a dreary monotony of buildings, as one might think. With the eyes of the engineers once opened to the possibilities which exist, we may expect to see the whole problem of housing approached from a new point of view and given a strong push toward solution.

City planning is another phase of this problem, and is, of course, much broader than housing. The restriction of buildings in height, bulk and use, as in the recent law of New York City, is an important development.

The New Engineering Education

To carry out the functions outlined the engineering profession must be a great composite of specialists and must contain also many men of broad attainments, education and experience. But all of the varying types of engineers must be held together by a common bond and that bond is *science*. The engineer applies science, drawing upon natural resources and the forces of nature in a large way for the use and convenience and happiness of man. The love of physical science, respect for mathematical law, and a constructive imagination are the foundation qualities of an engineer, but along with them must go an appreciation of human needs and desires.

To provide this body of specialists in applied science it will be necessary to maintain many engineering schools and to have these differ from one another. There must be manual-training schools, technical schools, and university schools of applied science; schools with courses of two years, four years, five and more years; schools with the usual academic terms, schools which run the year through, schools in which work and instruction are alternated, and schools in the evening. To have all technical schools standardized would be most unfortunate. To have a large number of moderate-sized schools might be better than a few very large schools. Overgrown schools have some of the faults of overgrown cities. There should be more competition in engineering education, but at the same time more coöperation in the use of large and expensive laboratories and machinery and more cross connections between schools.

Pure and Applied Science Merging

The war has completely and forever broken down the barrier between pure science and applied science. The teacher of pure science is no longer to live in isolation, to be placed on a pedestal or scornfully regarded as a theorist, and the man whose instincts are for organization and for the utilization of what is known must not claim too much for his achievements. So also has the barrier broken down between the arts man and the science man, and in my opinion the return to the study of the classics, of language, of literature, of history and of government by men who are planning to be engineers will take place to an increasing extent. The wider work in engineering will need a broader foundation.

Professor Mann, in his studies of engineering teaching in America, has emphasized the needs of character building and personality as primal requisites, and the importance of studying science, engineering practice

and the cost of works, and holds that the last two are receiving too little attention in the schools today. The reason why this has not been done is, of course, obvious; namely, that in the ordinary four years course there is not time to study all of the necessary fundamental subjects and at the same time go very far into such matters as practice and cost. To do this properly requires more than four years of study. Students intending to be lawyers, ministers or doctors expect to study not four years only, but six or seven. Why should the young man who wishes to become great in the profession of engineering expect to give less time to his preparation for a life's work? In the new democracy the country will need more men of this type.

The Engineering Society as a Graduate School

Many young men cannot afford to study more than four years, some cannot give even that time; and the engineering graduate does not immediately begin to practice or preach, as the doctor or the minister does, but, whatever his training, begins at the bottom and works up. This apprenticeship is necessary, and no amount of schooling can replace it. If the time in school is limited, it is all the more necessary, in my opinion, that it be spent in learning fundamental principles, and that specialization be not carried too far—not as far at it often is today. Where, then, is the young man, the ordinary technical school graduate, to learn about practice and costs and all that?

It seems to me that here is an opportunity for the engineering society which has thus far been neglected. Conditions ought to be such that the graduate in engineering entered some professional engineering society as a matter of course. Here he ought to find opportunities for learning about engineering practice and costs, in the best of all ways—that is by coming in contact with engineering works themselves and the men who build them.

It would not be a difficult matter for engineering societies to offer short courses of lectures given by the older members for the benefit of the younger. And I venture to say that members no longer juniors would be glad to attend such short courses in order to refresh themselves. Too much have our society meetings become mere formal lectures illustrated with lantern slides. These are all very well, but they are not enough. We need the more frequent meeting of small groups. I offer this as a recommendation—that the Boston Society of Civil Engineers arrange for a few series of short lectures in engineering practice during the coming year, for the benefit of members of the society.

Individualistic Democracy

My final thought recurs to the new democracy. I believe that when the good features of the socialist program have been sifted from the bad, there will follow a new organization of society in which individuality will be the prominent note. Although a democracy, it will be a highly specialized and well disciplined and organized democracy, where the natural inequalities of men and women will be recognized and rewarded but where all will have an equal chance to obtain the great satisfactions of life. But we shall never arrive at this condition unless our students throughout their entire school age are taught to develop their own personalities, unless we adopt some form of democratic military discipline, unless efforts are made to find the right job for the right man, and unless more efforts are made to bring different classes of workers and employers to sympathize with the contributions of each other to the common good.

But, above all and before everything else, we must win the war.

Old Toll Bridge Taken by Government Has Interesting History

THE old Missouri River bridge at Fort Leavenworth, recently seized by the Government to improve the connection between the fort and a newly developed reservation on the east side of the river, has a history that is representative of many private-company highway bridges. Inefficient service and the loss of a large part of the original investment feature the case.

The structure was built in 1872 by the Kansas & Missouri Bridge Co. for combined railway and highway use. Bonds for $750,000 were sold, largely in Holland, but after only four years the mortgage was foreclosed for default in interest. The buyers, the Leavenworth Bridge Co., executed a mortgage for $600,000 in 1880. Six years later a fire wrecked part of the bridge. Until 1894 the Rock Island and the Chicago Great Western operated over the bridge, but in that year they abandoned it for another crossing, and thereafter the old bridge was used for highway traffic only. In 1899 it was sold at foreclosure a second time, the Fort Leavenworth Bridge Co. becoming the owner.

The structure has three wrought-iron truss spans of the triple-intersection Post type, 312 to 337 ft. long, and about 32 ft. deep, and a long timber trestle across the bottomlands on the east side of the channel. The three piers consist each of a pair of cast-iron cylinders 8 to 12 ft. in diameter, filled with concrete and protected by masonry; one is on pile foundations, while the two others are on rock.

The decking is of wood, on floorbeams attached to the truss panel points by steel plate hangers.

The metal work of the bridge has remained in excellent condition. An examination five years ago showed it to be well preserved and, according to estimates, to have 90% of its original load-carrying capacity. The decking was badly decayed, however.

Six or eight years ago the east approach of the bridge, already seriously weakened by decay, was completely destroyed by high water and had to be rebuilt. In 1913 the wooden decking near the west end was partly destroyed by fire; no perceptible injury was done to the trusses or floorbeams, however.

Application repeatedly was made to the Government to assist in keeping the bridge in repair, but these appeals met with no response. A little over two years ago the removal of the bridge was again agitated by river interests, and a hearing was held at the U. S. Engineer Office in Kansas City. No action resulted. Now that the Government has taken over the bridge it will probably be restored to many years of useful service.

Divide Cost Five Ways on Alton Grade Separation

Extension of Electric Line Necessitates Alteration—Five Parties Share Expense—Bridge Will Be Slid Into Place

STREET depression and street diversion are the main points in the separation of grades at the intersection of the Chicago & Alton R.R. and College Ave., at Alton, Ill. The State of Illinois desired the Alton & Eastern Electric Ry. to extend its line on College Ave. to the new State Asylum for the Insane, but a railway grade crossing of the two lines was not permissible. To permit the building of this extension and also to provide a safer crossing for pedestrians and street vehicles, the plan for complete separation of the railway and street was adopted as the result of conferences between officials of the railways, the city and the State Public Utilities Commission.

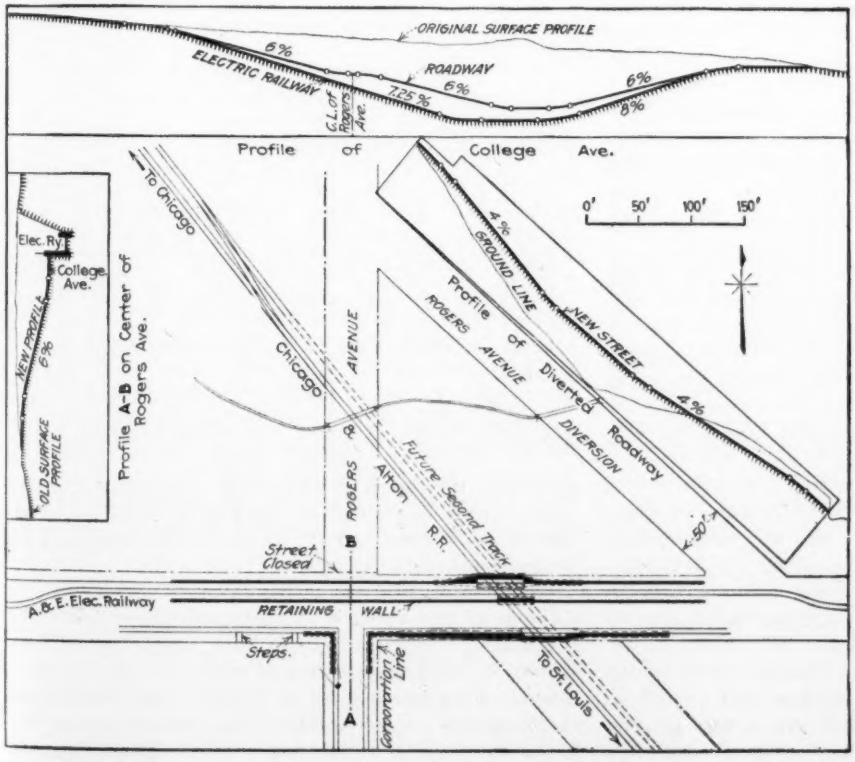
Practically no change is made in the grade of the Chicago & Alton tracks, which are raised only 4 in. The street is depressed 15 ft. at the crossing, with approach grades of 6 per cent., the change in grade extending over a distance of about 650 ft. This gives 12 ft. clear headway, which is sufficient for street traffic, but not for the electric cars. Any additional lowering would have involved longer approaches or steeper grades. To avoid these undesirable conditions, the street and electric railway grades are separated. The width of the street is divided into two sections, one side for the roadway and sidewalk and the other for the single-track electric line. This latter portion is depressed 3 ft. lower than the street at the Chicago & Alton crossing, and has approach grades of 8 per cent. and 7.25 per cent.

This separation of street and electric railway grades along College Ave. necessitates a change in an intersecting street, as the depressed track space made it impossible to carry Rogers Ave. across College Ave. The north side of the former street therefore is closed, and a new diagonal connecting road is built, as shown on the plan. This added some $1500 to the cost.

A single-track plate-girder through bridge carries the Chicago & Alton R.R. across the subway. The total width between abutments is 46 ft., including a 4-ft. sidewalk, 24-ft. roadway and 16-ft. track space for the electric line. The bridge has two spans, supported by the concrete abutments and a steel bent on the wall betwen the roadway and the electric line. It is designed for Cooper's E-60 loading.

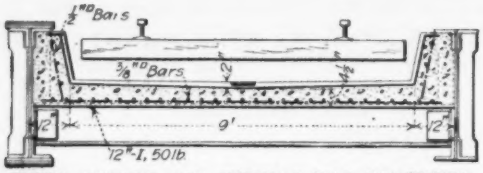
The solid floor construction consists of I-beams framed between the girders and carrying a reinforced-concrete deck slab. The surface of the slab is concave, forming a longitudinal drain with down-pipes, and its sides are carried up to the top of the girders, forming a trough for the stone ballast. On the concrete is a layer of mastic and waterproofing fabric having a thickness of 1½ in. at the sides and 2 in. at the center.

Wood forms were fitted between the 12-in. 50-lb. I-beams, which are spaced 19½ in. on centers. For convenience of removal the surface of the forms was just below the top flanges of the I-beams, so that these flanges are embedded in the concrete. The minimum depth of slab between I-beams, at the center of the floor, is 4½ inches.

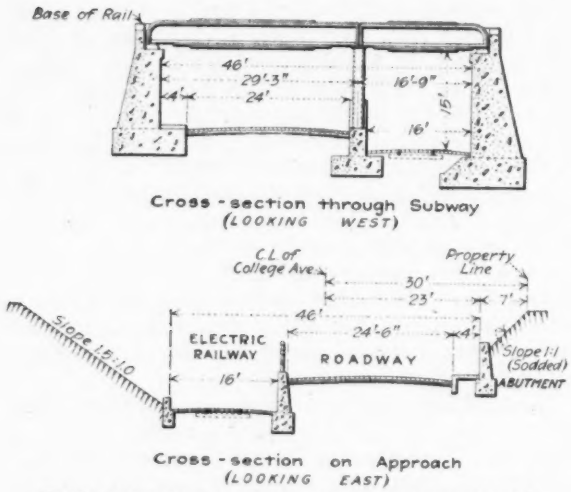


GRADE CROSSING ELIMINATION INVOLVES STREET LOWERING AND DIVERSION

For sliding the bridge into place each bent had a pair of 80-lb. rails spiked to the cap, with filled blocks placed between these at intervals of 8 ft. Before the girders were landed on the bents they were fitted with shoes, each consist-



STEEL BRIDGE FOR SUBWAY HAS CONCRETE FLOOR SLAB

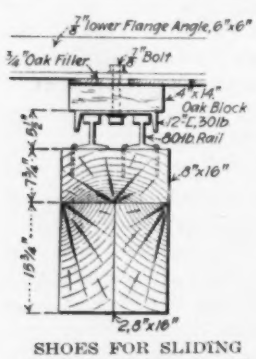


CROSS-SECTIONS ON COLLEGE AVE. DEPRESSION

ing of an oak block 4 x 14 x 18 in., and a 12-in. channel 18 in. long. Each shoe was bolted to the bottom chord angles in such position that when the girder was landed the channel fitted over the side rails and formed a guide, as shown in the detail drawing. A hoisting engine and cable will be used to slide the bridge into position when the substructure is ready.

Distribution of the cost among five parties is an unusual feature of the case. The State of Illinois was involved, since the extension of the electric line was made to serve the new State Asylum for the Insane, and there was no local traffic to warrant the company in making the extension on its own account. The township adjacent to the city was involved, since the Rogers Ave. diversion is outside the city limits.

The estimated cost is $36,000, including the street diversion. Of this, 31.67 per cent. will be paid by the State of Illinois, 33.33 per cent. by the Chicago & Alton R.R., 25 per cent. by the electric railway, 5 per cent. by the city of Alton, and 5 per cent. by the township of Wood River. The cost of consequential damages is assumed by the city and the township within their respective corporate limits.



SHOES FOR SLIDING BRIDGE INTO PLACE

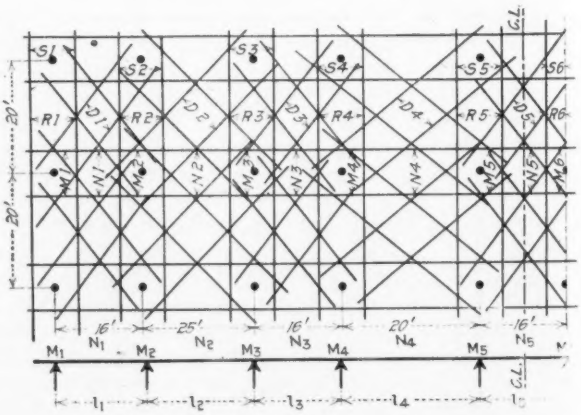
Work was begun in June, 1917, and will be completed in the spring. J. J. Wuelner & Son have the contract for grading, masonry and paving. The bridge is being built by the American Bridge Co., and it will be moved into place by the railway company's forces as described above. Plans for the improvement were prepared by J. W. Reid, bridge engineer, under the direction of H. T. Douglas, Jr., chief engineer of the Chicago & Alton R. R. These were approved by the other parties interested and by the State Public Utilities Commission. The execution of the work was under the direction of the railway company, J. E. Schwaab being resident engineer in charge. H. F. Merker is engineer for the Alton & Eastern Electric Railroad.

Computing Moments on Irregularly Spaced Flat-Slab Panels

By Using Three-Moment Theorem, Girderless Concrete Floors with Odd Length Column Spacings Can Be Analyzed

BY W. STUART TAIT
Vice President and Chief Engineer, Concrete Steel Products Co., Chicago

THE analysis of the moment distribution in a reinforced-concrete flat-slab floor system with panels spaced irregularly in one direction and constant in the other has not been published, to the writer's knowledge. Such a construction, however, is not unusual, especially as considerable irregularity in column spacing is permitted by the customary restriction of the ratio between the two sides of a panel to four-thirds. By the application of Clapeyron's Theorem of Three Moments the writer has made an analysis which gives results which agree with the established rules for the design of flat-slab construction. Herewith is worked out such an analysis for the arrangement of spans shown in the



MOMENTS IN IRREGULARLY SPACED FLAT-SLAB SPANS

accompanying diagram, that is for panels uniformly 20 ft. long in one direction and varied in the other direction as follows: 16 ft., 25 ft., 16 ft., 20 ft. and a central panel of 16 ft.

The bending moment at the exterior column will be taken as $wL/60$, where w = total exterior panel load and L the span. This moment has been established and accepted by many engineers and while it varies slightly depending on the relative stiffness of the column and slab and also on the profile of the bracket on the exterior column, it is a reasonable value. After accepting this moment the other moment the other moments M_2

M_2, etc., will be found by Clapeyron's Theorem, as follows:

$$M_1 = -\frac{WL}{60} = -\frac{w \times 20 \times l_1^2}{60} = -\frac{wl_1^2}{60} \text{ per ft. width} \quad (1)$$

$$M_1 l_1 + 2M_2(l_1 + l_2) + M_3 l_2 = -\frac{w(l_1^3 + l_2^3)}{4} \quad (2)$$

$$M_2 l_2 + 2M_3(l_2 + l_3) + M_4 l_3 = -\frac{w(l_2^3 + l_3^3)}{4} \quad (3)$$

$$M_3 l_3 + 2M_4(l_3 + l_4) + M_5 l_4 = -\frac{w(l_3^3 + l_4^3)}{4} \quad (4)$$

$$M_4 l_4 + 2M_5(l_4 + l_5) + M_6 l_5 = -\frac{w(l_4^3 + l_5^3)}{4} \quad (5)$$

Consider the moments per lin.ft. of slab only.

$\therefore M_1$ becomes $-\frac{w \times 1 \times 16^2}{60} = -4.27w$

Substituting in Eq. 2, we get $82\,M_2 + 25\,M_3 = -4861.8\,w$

Substituting in Eq. 3, we get $25\,M_2 + 82\,M_3 + 16\,M_4 = -4930.2\,w$

Substituting in Eq. 4, we get $16\,M_3 + 72\,M_4 + 20\,M_5 = -3024\,w$

Substituting in Eq. 5, we get $20\,M_4 + 88\,M_5 = -3024\,w$

Solving these simultaneous equations

$$M_1 = -4.27\,w$$
$$M_2 = -46.8\,w$$
$$M_3 = -41\,w$$
$$M_4 = -24.9\,w$$
$$M_5 = -28.6\,w = M_6$$

Now find the positive moments N_1, N_2, etc., as follows:

$$N_1 = \frac{wl^2}{8} - \tfrac{1}{2}(M_1 + M_2)$$

$$N_1 = 6.47\,w \quad (6)$$
$$N_2 = 34.23\,w \quad (7)$$
$$N_3 = -0.95\,w \quad (8)$$
$$N_4 = 23.25\,w \quad (9)$$
$$N_5 = 3.4\,w \quad (10)$$

The quantities M_1, M_2, etc., and N_1, N_2, etc., are the bending moments per lin.ft. at their respective points for the series of spans shown in the diagram and are based on one-way construction. If we obtain a value for N_1 similar to the above but where l_1, l_2, etc. are all 16-ft. spans and for this new value we write Q_1, we can, by dividing N_1 by Q_1, obtain a factor C_2. This factor C_2 is an exact expression of the influence of the unequal arrangement of spans on the moment at the center of the first span. So, also, if we obtain a similar value for N_2, but where l_1, l_2, etc., are all 25-ft. spans, and for this new value write Q_2, we can obtain a factor $C_4 = N_2/Q_2$. Similarly this factor C_4 is an expression of the influence of the unequal arrangement of spans on the moment at the center of the second span.

Assume the total bending moment at the center of the span in the direct band or the positive moment at the outer section in flat-slab construction as $= 0.0116\,w\,l_1\,l_2^2$ for an interior panel, whose sides are l_1 and l_2, which is in accordance with the American Concrete Institute ruling. This value is based on a series of equal spans in each direction. If therefore we had a series of panels 25 ft. by 20 ft., the moment in a direct band at the point corresponding to N_2 would be $= 0.0116\,w \times 20 \times 25^2$. By multiplying this moment by the influence factor C_4, we obtain the moment in the direct band at this point in the series of unequal span shown.

Thus solving Eq. 6 for equal spans of unit length and writing Q_1 for N_1,

$$Q_1 = \frac{wl_2}{2} - \tfrac{1}{2}(M_1 + M_2) = 0.065w$$

and transposing by multiplying by l_1^2, as indicated in the preceding paragraph, the new bending moment Q_1 so derived will be the moment occurring in the first span, assuming that the moment obtained is that occurring in a span adjoined by a number of spans equal to it. Then

$$Q_1 = 0.065\,w\,l_1^2 = 16.6\,w$$

By a similar operation then

$$Q_2 = 0.035\,w\,l_2^2 = 2.8\,w$$
$$Q_3 = 0.044\,w\,l_3^2 = 11.3\,w$$
$$Q_4 = 0.042\,w\,l_4^2 = 16.8\,w$$
$$Q_5 = 0.043\,w\,l_5^2 = 11.0\,w$$

The solution for negative moments is rather more complicated. The values M_2, M_3, etc., are the bending moments at the supports per foot width for one-way construction for the spans shown. The total bending moment at the column head section again based on equal spans is $0.0325\,w\,l_1 l_2^2$, where l_1 and l_2 are the sides of the panel considered.

Referring, now, to the diagram, the moment at point M_2 could either be written $0.0325\,w\,s\,l_2^2$ or $0.0325\,w\,s\,l_3^2$ or the mean of l_2 and l_3, or could be used thus, $0.0325\,w\,s\,(l_2 + l_3)^2$. So long as we use the same form of equation in obtaining the value of P_2 and later the flat-slab bending moment at this point, identical results will be obtained. It was, therefore, decided to use the third form of equation and in calculating the negative moments always to use the mean to the adjoining spans.

Thus solving Eq. 1 for equal spans of unit length and writing P_1 for M_1

$$P_1 = -0.0167\,w$$

and transposing as noted in the previous paragraph

$$P_1 = -0.0167\,w\,l_1^2 = 4.27\,w$$

On this page is a tabulation of M_1, M_2, etc., N_1, etc., P_1, P_2, etc., Q_1, Q_2, etc., and also C_2, C_4, etc.

TABULATION OF MOMENTS AND COEFFICICATS FOR IRREGULAR SPANS
All Values Given Are Multiplied by W

Values of Moments for series of unequal spans	M_1	N_1	M_2	N_2	M_3	N_3	M_4	N_4	M_5	N_5
	−4.27	6.47	−46.8	34.2	−4.10	−0.95	−24.9	23.25	−28.6	3.4
Values of Moments for series of equal spans	P_1	Q_1	P_2	Q_2	P_3	Q_3	P_4	Q_4	P_5	Q_5
	−4.27	16.6	−42.8	21.8	−33.1	11.3	−27.2	16.8	−26.9	11.0
	$\frac{M_1}{P_1} = C_1$	$\frac{N_1}{Q_1} = C_2$	$\frac{M_2}{P_2} = C_3$	$\frac{N_2}{Q_2} = C_4$	$\frac{M_3}{P_3} = C_5$	$\frac{N_3}{Q_3} = C_6$	$\frac{M_4}{P_4} = C_7$	$\frac{N_4}{Q_4} = C_8$	$\frac{M_5}{P_5} = C_9$	$\frac{N_5}{Q_5} = C_{10}$
Multiplying factor to obtain correct flat slab moments $\frac{M_1}{P_1}$, etc.	1	0.39	1.1	1.57	1.24	−0.085	0.92	1.38	1.06	0.31

This may be continued as follows:

$$P_2 = -0.102w\frac{(l_1 + l_2)^2}{2} = -42.8w$$

$$P_3 = -0.079w\frac{(l_2 + l_3)^2}{2} = -33.1w$$

$$P_4 = -0.084w\frac{(l_3 + l_4)^2}{2} = -27.2w$$

$$P_5 = -0.083w\frac{(l_4 + l_5)^2}{2} = -26.9w$$

The application of the development to the moment P_2, for instance, will then be as follows: If the value M_2 be divided by P_2, we will obtain a coefficient C_2, which is an exact expression of the influence upon the bending moments of the unequal spans shown. Then the total bending moment in the column head section at this point in the series of spans shown $= 0.0325\,w\,s\frac{(l_2 + l_3)^2}{2} \times C_2$.

The above treatment applies only to the rectangular bands running directly across the spans shown in the diagram. A similar analysis can be prepared for the diagonal band by considering the series of spans applying as the mean between the spans shown and 20 ft. the span in the other direction. Thus for the diagonal band analysis l_1 becomes $\frac{16 + 20}{2} = 18$ ft. and l_2 22 ft. 6 in., etc. In extreme cases it is well to make this analysis, but in general it will be satisfactory to arrive at factors for the diagonal bands by taking the mean between the above factors C_1, C_2, etc., and unity, and apply these to the diagonal band. It is also apparent that since the entire bending moment at the columns is provided for by analysis in the two rectangular directions only that no factors will be required for negative moments in the diagonal bands. Accordingly we have the following factors:

ALL VALUES GIVEN ARE MULTIPLIED BY W

	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}
Multiplying factor to obtain the moment in Diagonal Band	0.7	1.29	0.46	1.19	0.66

Having these coefficients the determination of the moments can then be found on the basis of the following moments as determined for a flat-slab of even column spacing.

Col. Head Section $= 0.0325\,w\,l \times l_2^2$

Middle Section $= 0.0065\,w\,l \times l_2^2$

Direct Band on Outer Section $= 0.0116\,w\,l_1 \times l_2^2$

Diagonal Band on Inner Section $= 0.00775\,w\,l_1 \times l_2^2$

All of these are in accordance with the ruling of the American Concrete Institute, as noted in Vol. XIII of its "Proceedings."

Assuming that w = total load per sq.ft. = 300 lb. and that the column spacing in the direction normal to the irregular spans is 20 ft., we find

$$M_1 = \frac{w}{60} \times 20 \times 16^2 \times C_1 = -25{,}600 \text{ ft.-lb.}$$

$$N_1 = \frac{120}{100} \times 0.0116 \times w \times 20 \times 16^2 \times C_2 = 8450 \text{ ft.-lb.}$$

$$M_2 = \frac{120}{100} \times 0.0325 \times w \times 20 \times \frac{(l_1 + l_2)^2}{2} \times C_2 = \frac{120}{100} \times 0.0325 \times 300 \times 20 \times 20.5^2 \times 1.1 = -109{,}000 \text{ ft.-lb.}$$

$$N_2 = 0.0116 \times 300 \times 20 \times 25^2 \times 1.57 = 68{,}000 \text{ ft.-lb.}$$

$$M_3 = 0.0325 \times 300 \times 20 \times 20.5^2 \times 1.24 = -102{,}000 \text{ ft.-lb.}$$

$$N_3 = 0.0116 \times 300 \times 20 \times 16^2 \times -0.085 = -1520 \text{ ft.-lb.}$$

$$M_4 = 0.0325 \times 300 \times 20 \times 18^2 \times 0.92 = -58{,}000 \text{ ft.-lb.}$$

$$N_4 = 0.0116 \times 300 \times 20 \times 20^2 \times 1.38 = 38{,}200 \text{ ft.-lb.}$$

$$M_5 = 0.0325 \times 300 \times 20 \times 18^2 \times 1.06 = -67{,}000 \text{ ft.-lb.}$$

$$N_5 = 0.0116 \times 300 \times 20 \times 16^2 \times 0.31 = 5500 \text{ ft.-lb.}$$

Now consider the direct bands normal to the above. Referring to the diagram of the bands it is apparent that each whole band must be split into two half bands to arrive at the total moment. Thus, in the case of moment R_2 this moment is made up of one-half of a direct band of 20-ft. span in each of two panels 16 x 20 ft. and 25 x 20 ft.

We therefore find as follows:

$$R_1 = \tfrac{1}{2} \times 0.0116\,w\,l_2 \times l_1^2 = \tfrac{1}{2} \times 0.0116 \times 300 \times 16 \times 20^2 = 11{,}100 \text{ ft.-lb.}$$

$$R_2 = \tfrac{1}{2} \times 0.0116\,w\,(16 \times 20^2 + 25 \times 20^2) = 28{,}500 \text{ ft.-lb.}$$

$$R_3 = \tfrac{1}{2} \times 0.0116\,w\,(25 \times 20^2 + 16 \times 20^2) = 28{,}500 \text{ ft.-lb.}$$

$$R_4 = \tfrac{1}{2} \times 0.0116\,w\,(16 \times 20^2 + 20 \times 20^2) = 25{,}000 \text{ ft.-lb.}$$

$$R_5 = \tfrac{1}{2} \times 0.0116\,w\,(20 \times 20^2 + 16 \times 20^2) = 25{,}000 \text{ ft.-lb.}$$

$$R_6 = R_5 = 25{,}000 \text{ ft.-lb.}$$

Similarly:

$$S_1 = -\tfrac{1}{2} \times 0.0325\,w \times 16 \times 20^2 = -31{,}300 \text{ ft.-lb.}$$

$$S_2 = -\tfrac{1}{2} \times 0.0325\,w\,(16 \times 20^2 + 25 \times 20^2) = -80{,}000 \text{ ft.-lb.}$$

$$S_3 = -\tfrac{1}{2} \times 0.0325\,w\,(25 \times 20^2 + 16 \times 20^2) = -80{,}000 \text{ ft.-lb.}$$

$$S_4 = -\tfrac{1}{2} \times 0.0325\,w\,(16 \times 20^2 + 20 \times 20^2) = -70{,}500 \text{ ft.-lb.}$$

$$S_5 = -\tfrac{1}{2} \times 0.0325\,w\,(20 \times 20^2 + 16 \times 20^2) = -70{,}500 \text{ ft.-lb.}$$

$$S_6 = S_5$$

Turning to the diagonal bands, we find in the ruling of the American Concrete Institute that the moment across the inner section $= 0.00775\,w\,l_1 \times l_2^2$ in one direction and $= 0.00775\,w\,l_2 l^2$ in the direction normal to this. Now the moment in each diagonal band will be equal to half the sum of these two values. In this particular case, owing to the irregular spans, the values thus obtained must be multiplied by the coefficient C_{11} to C_{15}. We find, then,

$$D_1 = \tfrac{1}{2}\,0.00775\,w\,(l_1 \times l_2^2 + l_2 \times l_1^2) \times C_{11} \times \frac{120}{100} = \tfrac{1}{2}\,0.00775 \times 300(16 \times 20^2 + 20 \times 16^2) \times 0.7 \times \frac{120}{100} = 12{,}200 \text{ ft.-lb.}$$

$$D_2 = \tfrac{1}{2}\,0.00775 \times 300\,(20 \times 25^2 + 25 \times 20^2) \times 1.29 = 36{,}500 \text{ ft.-lb.}$$

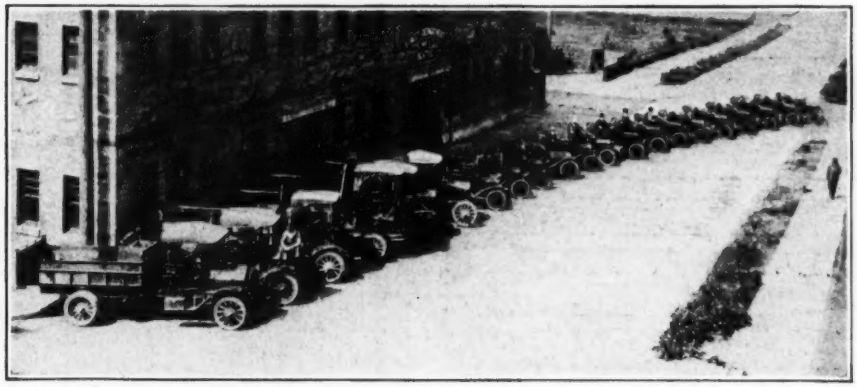
$$D_3 = \tfrac{1}{2}\,0.00775 \times 300\,(16 \times 20^2 + 20 \times 16^2) \times 0.46 = 6700 \text{ ft.-lb.}$$

$$D_4 = \tfrac{1}{2}\,0.00775 \times 300\,(20 \times 20^2 + 20 \times 20^2) \times 1.19 = 24{,}100 \text{ ft.-lb.}$$

$$D_5 = \tfrac{1}{2}\,0.00775 \times 300\,(16 \times 20^2 + 20 \times 16^2) \times 0.66 = 9650 \text{ ft.-lb.}$$

From these bending moments the slab can be designed in the usual manner, making adjustments to these moments to satisfy the minimum moment requirements of the building code being used.

Seattle Keeps Accurate Records of Auto Trucks and Automobile Operations



Street and Sewer Department Cuts Operating Costs in Half in Two Years—Complete Daily, Monthly and Yearly Records for Each Car—Comparative Results for Cars Summarized and Posted

By C. A. Osier
Seattle, Wash.

BY SUBSTITUTING accurate and complete cost records for haphazard and useless typewritten memoranda and securing the active coöperation of all concerned, the street and sewer department of Seattle reduced the daily operating cost of auto trucks from $12 to $15 in 1913 to an average of $7.46 in 1916 and $8.81 in 1917, the rise in 1917 as compared with 1916 being due to increased prices of labor and materials. The record system covers the 14 automobiles as well as the 11 trucks owned by the department, the value of which totals $50,000.

When a machine leaves the garage in the morning it is in good running order. Each driver signs up (and later on surrenders) his car on a daily record sheet which covers all the trucks and automobiles owned by the department. The original of this form (No. 1) is sent to the main office and the duplicate held in the machine shop. The head machinist is thus able to keep in touch with all the cars in his charge, and by giving immediate attention to needed minor repairs the number of cars that are idle is reduced to a minimum.

Each truck driver makes out a daily report (Form No. 2) on work done and supplies used. This is checked by the stock clerk before final compilation in the office. Gasoline and oils are supplied to the machines only through the foreman in charge of the garage division. At the close of the day the amounts of these are assembled on Form No. 3, which also includes records for the cars owned by the department.

When a machine requires extensive repairs an estimate is made on Form No. 4 and submitted to the superintendent for approval. A work order (No. 5) authorizing such work is then issued, and all time and material are recorded daily on the form for that purpose (No. 6) until the work is completed, when a comparison is made of the estimate and the final cost.

Tire records (Form 7) give a complete history of every tire in use. As a result the department in one year saved in rebates alone the sum of $698.97. By this method it is known when a tire has outlived its

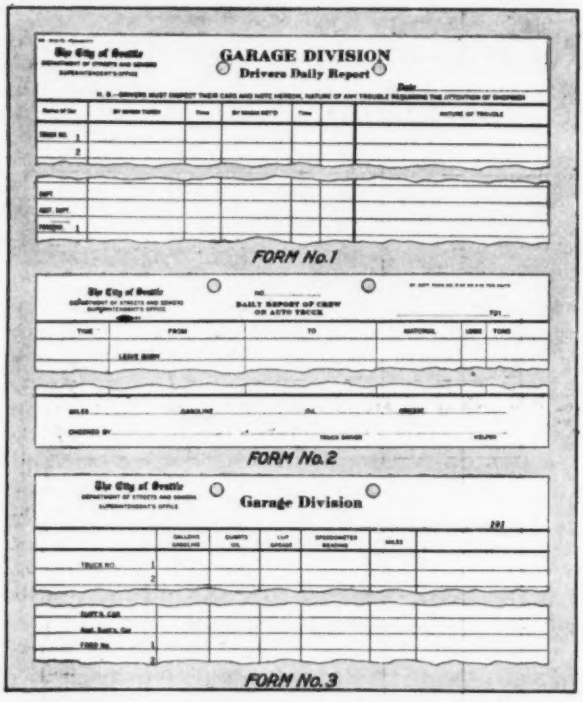
OPERATION OF AUTO TRUCKS IN SEATTLE STREET AND SEWER DEPARTMENT, DEC. 1, 1915, TO NOV. 30, 1916

	Gas	Oil	Wages	Depreciation — Machine	Depreciation — Tires	Undistributed — Time	Garage	Total
Gramm—1910—3T	$141.42	$28.70	$548.15	$95.52	$156.57	$22.29	$59.56	$1,052.21
Gramm—1911—3T	251.30	33.35	880.49	186.56	263.14	22.29	81.56	1,718.69
Velie—1914—1 T	180.74	18.06	813.94	257.29	200.73	22.27	79.91	1,572.94
Gramm—1912—3 T	210.76	47.59	760.42	201.01	202.22	22.28	81.77	1,526.05
P-A—1912—5T	234.92	21.66	741.49	181.17	271.51	22.25	69.48	1,542.48
*G. M. C. Eductor—1915—3½ T	213.17	13.69	903.23	421.73	161.01	16.05	57.79	1,786.67
Velie—1916—2½ T	170.68	11.08	604.53	353.96	169.50	14.60	46.36	1,370.71
Totals	$1,402.99	$174.13	$5,252.25	$1,697.24	$1,424.68	$142.03	$476.43	$10,569.75

COMPARATIVE UNIT COSTS

	Miles	Average Cost Per — Day	Mile	Gas and Oil Mile	Average Miles Per Gallon — Day	Gas	Quart — Oil	Tons	Cost per Ton	Tons per Day	Tons per Trip	Trips
Gramm—1910—3 T	5,014.0	$6.77	$0.209	$0.033	32.2	3.84	13.5	2,532.7	$0.415	16.28	2.67	948
Gramm—1911—3 T	8,922.8	6.57	.192	.031	34.1	3.88	20.7	6,387.5	.269	24.42	3.23	1,974
Velie—1914—1 T	8,044.7	6.79	.195	.024	34.7	4.89	34.52	4,026.5	.390	17.4	1.26	3,167
Gramm—1912—3 T	6,788.2	7.06	.224	.038	31.42	3.54	11.05	5,201.6	.293	24.08	3.56	1,460
P-A—1912—5 T	6,784.8	7.34	.227	.037	32.29	3.16	24.2	5,517.9	.279	26.26	3.75	1,468
*G. M. C. Eductor—1915—3½ T	4,870.3	10.49	.367	.046	28.56	2.51	7.57	3,220.0	.555	18.88	3.77	853
Velie—1916—2½ T	6,960.0	8.03	.197	.026	40.8	4.48	8.6	1,903.6	.72	11.16	2.23	852
Totals	47,384.8	$7.47	$0.223	$0.029	32.7	3.71	21.1	28,789.8	$0.367	20.3	2.69	10,722

* The G. M. C. Eductor is a catch-basin power-cleaning machine.



FORMS TO HELP REDUCE OPERATING COST

The original sizes of the forms shown were as follows. (1) 12 x 14 in., with carbon duplicate. (2) 8 x 3½ x 8½ in. (3) 8½ x 14 in. (4) 5½ x 8½ in. (5) 8½ x 5½ in., with two carbon duplicates. (6) 14 x 10 in. (7) 23½ x 14 in. (8) 26 x 17 in.

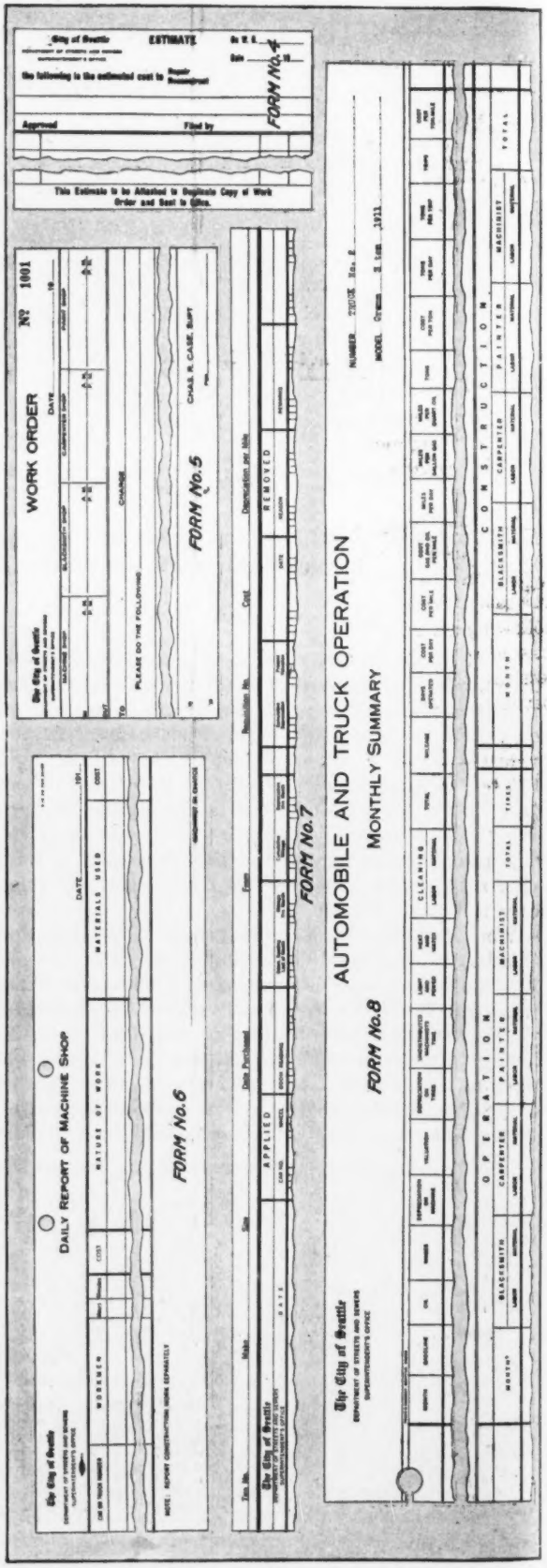
mileage guarantee. Thus, when a tire overlaps its guarantee, it will result in reducing the operating cost. The department has had tires showing the remarkable run of 10,000 miles.

At the end of each month there is made up for each automobile and truck in the department a record of operating costs for the month (Form No. 8). Finally this information, in somewhat condensed form, is brought together in a table (reproduced herewith). A copy of this table is placed in each station from which trucks operate. A friendly competition then ensues to reduce costs. The results gained in the contest are gratifying.

The automobiles are used only by department officials on business and they make out their own reports for record at the main office.

Truck drivers were paid $90 a month until January, 1917, then $100 until May 1, 1917, and since then $110 a month. They work eight hours a day from the time they leave until they return to the barn. They leave and return to the barn half an hour earlier than the other employes, to enable the repair men to remedy any minor defects before the next day, thus reducing to a minimum the time a car has to be kept in the shops. Slight resentment at being required to make itemized daily reports quickly gave way to a warm interest on the part of each driver in the records of his car and an effort to make a better showing than his fellow drivers.

The system described was worked out by M. S. Meengs, chief clerk of the street and sewer department under Charles R. Case, superintendent. It affords one of the most accurate and efficient cost systems used in any branch of the city work of Seattle.



Russian Engineers Make Intensive Hydrometric Survey in Crimean Upland

Individual Flow of 1500 Springs and 150 Streams and Total Yield of 25 Drainage Basins Being Measured—Portable Weirs, Flumes, Compound Weirs, Floats and Current Meters Employed

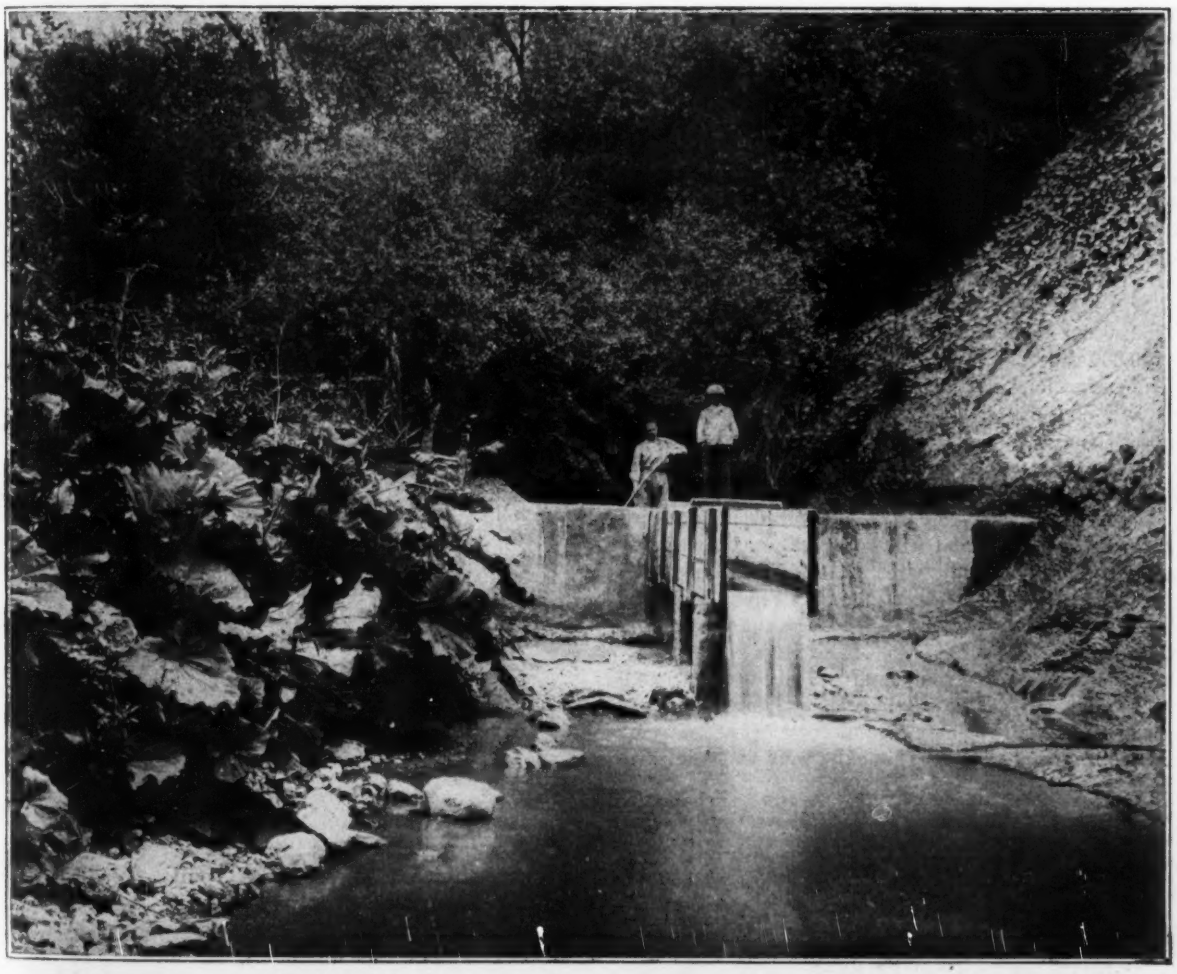
By D. Kotcherin
Engineer-Manager Hydrometric Service, Crimean Water Investigations, Simferopol, Russia.

A MINUTE hydrometric survey of the upland regions of the Russian province of Crimea is being made by the engineering division of the land improvement department of that province. The water is in such great demand for domestic and agricultural purposes, including irrigation, that measurements are being made of the flow of hundreds of springs and scores of small streams as well as of the rivers. Normal flows are low. Flood flows of streams go far to the other extreme. Consequently a variety of gaging devices is used—buckets, wiers and flumes; gages, floats and current meters.

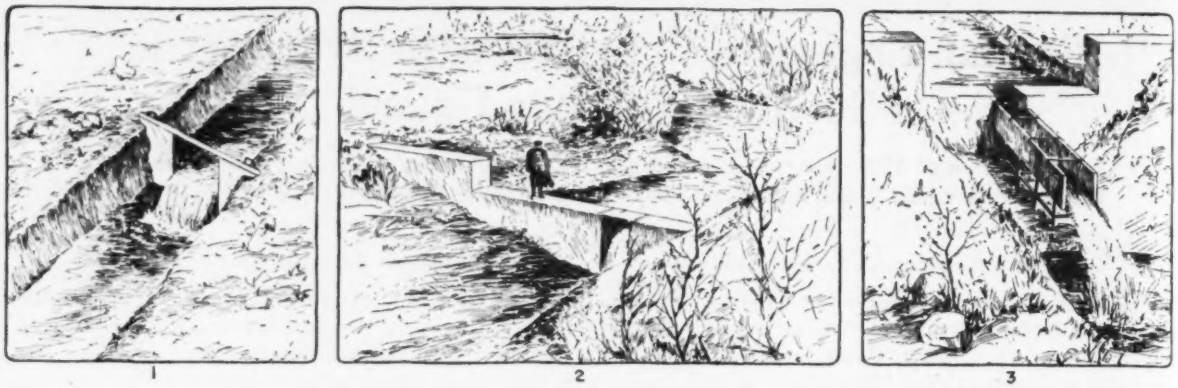
The engineering division for Crimean water investigations was established in 1913. Besides hydrometrical investigations it is charged with studies of meteorology, geology, topography, soil and meadow cultivation. Water regimen studies are of the utmost importance to the province of Crimea, not only because its large agricultural potentialities depend upon irrigation but also because of the lamentable destruction wrought by torrents when the streams are in high flood.

As shown by the accompanying geological section of the Crimean peninsula, Chadirdag to Simferopol, the principal mountain range falls sharply to the sea on one side and descends much more gradually on the other.

The range reaches an elevation of 2500 to 5000 ft. Its "Gaila" or "sponge summit" of cavernous limestone and its underlying porous conglomerates and sandstone absorb and store rainfall which springs to the surface on either slope when it meets the clay below. Fortunately for Crimean agriculture, the myriads of springs



TO DETERMINE THE FLOW OF THE KISIL-KOBA A MEASURING FLUME WAS USED INSTEAD OF A WEIR



A VARIETY OF MEASURING WEIRS AND FLUMES WAS USED TO MEET DIVERSE CONDITIONS

(1) Portable weir for irrigation ditches. (2) Small removable weir for dry-weather flow set in large flood-flow weir; the small weir is removed to sluice out deposits in the basin. (3) Measuring flume for small flows and weir for flood measurements. Views (1) and (3) from Russian sketches; (2) from a photograph of a weir on the stream Marba.

which give out the ground-stored water are located well above the cultivable area, and thus the streams which they feed serve readily for irrigation and other rural uses, as well as for municipal water-supply.

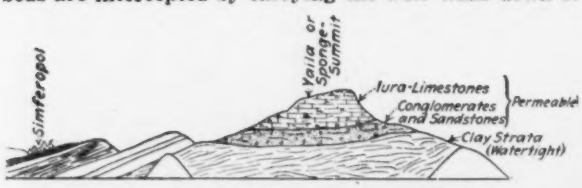
The value of these waters is so great that it is considered to be imperative to record the flow of even the smallest springs. Accordingly, the engineering division is now systematically measuring not only the total output of each of 25 basins but also the flow of 150 streams and 1500 springs, each [of the springs?] discharging an average of 10,000 liters daily or 0.16 liters per second. The mean yearly flow of little streams is 0.01 and of moderate-sized streams, like the Ulu-uzen in Alushta, 0.1 to 0.3 cu.m. per sec. For the Saligir, in Simferopol, one of the largest streams in the country, the average yearly discharge is 1 to 2 cu.m. per sec., while in midsummer it falls to 0.1 to 0.2 cu.m. In a very dry year the Saligir has no visible discharge.

In general, the streams of Crimea have either a very low or a high flow. That is, if the dry-weather flow is 10,000 veder (buckets) daily then the flood flow is 10,000,000 veder.

The irrigation canals head at points in streams considerably above the lands to be watered, requiring gaging stations above the canal heads. Lower down, springs on the banks or inflowing tributaries require additional stations.

The discharge of springs is measured by a vedro (bucket); or gorges and ariks (irrigation ditches) by portable weirs; of small streams, by weirs and measuring flumes; and of larger and main streams by floats, by current meters and by gages recording maximum flood heights.

In flashy streams a compound weir is used, a small weir for dry-weather flow being notched into the barge or flood-water weir. Underground flows beneath stream beds are intercepted by carrying the weir walls down to the watertight stratum. As the Crimean streams carry much rubble and silt, which in a short time fill the basins back of the weirs, removable weir frames are provided so the deposits can be sluiced out. In some instances measuring flumes extend downstream from a notch in a flood weir.



GEOLOGICAL SECTION OF CRIMEAN PENINSULA AFFORDS GROUND STORAGE FOR SPRING FED STREAMS

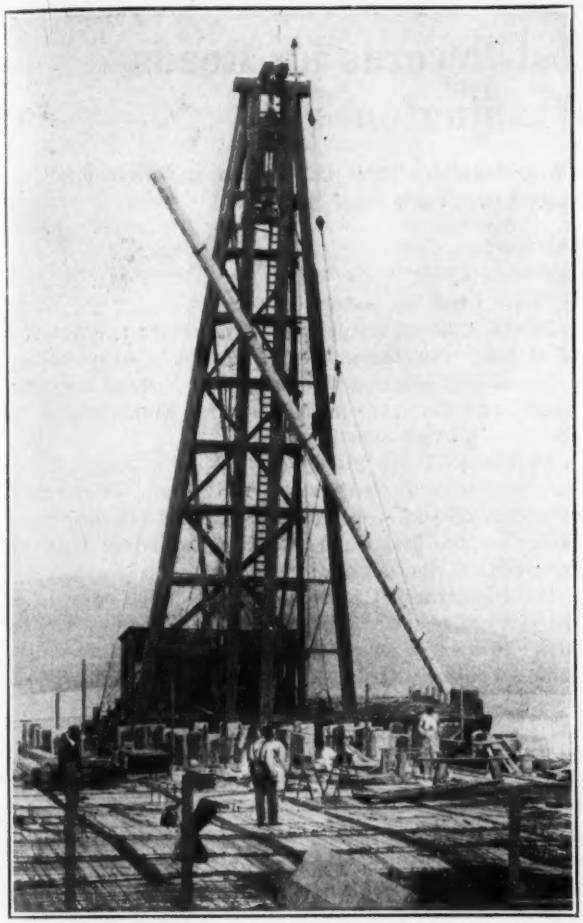
For administrative purposes upland Crimea is divided into small hydrometric units, 7 to 10 kilometers in diameter, with natural drainage-area boundaries. For each district there are an observer and helpers. These helpers make daily tours over certain parts of the district, according to a monthly schedule, recording the flow at the various stations. Special storm-water stations are located in the lower portions of the streams, near habitations, with water-level gages and time points for ascertaining velocities by floats. Current meters are used at public bridges. Many stations are provided with self-recording maximum flood-height gages.

Steel Saved in the Design of Concrete Piles

Change Is Made from Four- to Five-Point "Pick-Up" for 100-Foot Piles—Steel Is Put Only Where Stresses Require It

IN PIER construction at San Francisco the experience of seven years with concrete piles has resulted in numerous changes in the design now being used by the State Board of Harbor Commissioners. Special attention has been given to improvements which reduce the amount of steel required because of the very considerable economies this means with the present high price of steel. As an example of the advance made it may be said that the same amount of steel used on 66-ft. piles six years ago is now used successfully in 95-ft. piles.

The latest improvement in design, which saves 25% of the steel without decreasing the strength, it is believed, is the change from 4- to 5-point pick-up, leaving out the reinforcing where it would not carry stress. This necessitated fixing upon the points at which the slings would be attached as well as indicating the plane in which the pile was to be raised. By doing this the intermediate bars, one of which was formerly placed on each side, can be left out altogether and the interme-



HANDLING A 100-FOOT PILE WITH FIVE-POINT "PICK-UP"

diate bars on top and bottom are not run for the full length of the pile. The four corner bars, of course, are still run for the full length as formerly.

Piles over 90 ft. long are designed to be supported at the $\frac{1}{10}$, $\frac{3}{10}$, $\frac{5}{10}$, $\frac{7}{10}$ and $\frac{9}{10}$ points. The supports consist of three sets of bridles each having a sheave at the bight so as to equalize tension in the lines as the pile is raised. Ordinarily the piles are picked up from a barge alongside a floating driver and under these conditions the bridle carrying the two sheaves takes the lower end of the pile, as the pile can thus be most conveniently raised to an upright position. As the pile is lifted from the barge it is eased off by means of a snubbing line to a position in front of the leads. As it is inclined from horizontal toward the vertical in the process of lifting, the cross bending stresses rapidly decrease.

An analysis of a 100-ft. pile held in a horizontal position by the 5-point pick-up indicates a maximum bending moment of 35,000 ft.-lb. Based on this fact and experience on previous pile construction, an empirical rule has been adopted providing for a moment of $0.0165\ WL^2$, where W is the weight per linear foot and L is the total weight of the pile. In this rule an impact factor of approximately 100% is allowed for in the value of 0.0165. Only the bars on the tension side are assumed to be acting and in these 16,000 lb. per sq.in. is allowed.

Previously eight bars were run the full length of the pile, four at corners with an intermediate bar in each face. But applying this rule to piles from 70 to 100 ft. long, the intermediate bars on two sides are omitted entirely and in the other two sides they run only about 70% of the length.

If the pile is analyzed as a concrete beam with tension and compression acting in both concrete and steel,

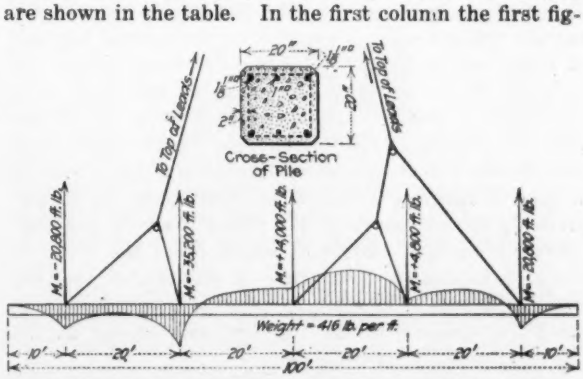
DATA USED IN DESIGN OF CONCRETE PILES

Type	Length	Lb. Steel Per Ft. of Pile: Bars	Lb. Steel Per Ft. of Pile: Wires	Cu. Ft. Concrete Per Ft. of Pile (Approx.)	Wt. in Lb., Per Ft.	Safe M (Inch Lb.) with Steel at 16,000 Lb. M = 0.875 × d × 16,000 Lb.: 2 Bars Acting	Safe M (Inch Lb.) with Steel at 16,000 Lb. M = 0.875 × d × 16,000 Lb.: 3 Bars Acting	As a Beam: Effective Depth, Inches	As a Beam: Steel, Sq. In.
¾-0-16	—to 45	7 65	1 90	1 75	263	214,500	in. lb.	13 62	1 125
¾-0-16	46 to 60	10 50	1 90			290,600	.....	13 56	1 531
¾-0-18	—to 50	7 65	2 21	2 22	333	246,000	.....	15 62	1 125
¾-0-18	51 to 60	10 50	2 21			333,500	.....	15 56	1 531
¾-¾-18	61 to 70	13 25	2 21			333,500	456,000	15 56	2 094
¾-¾-20	71 to 79	14 28	2 54	2 75	413	376,400	564,700	17 56	2 297
1-¾-20	80 to 89	16 43	2 54			490,000	627,900	17 50	2 563
1-1-20	90 to 95	18 37	2 54			490,000	735,000	17 50	3 000
1¼-1-20	96 to 100	22 11	2 54			618,000	862,100	17 44	3 531

the extreme fiber stress for loading of 35,000 ft.-lb. is about 240 lb. per sq.in. The concrete used is 1 : 5 mix, 45 days old, which is expected to carry 300 lb. per sq.in. in tension. Thus if handled with care the stresses should not exceed the tensile resistance of the concrete. In fact, it is believed that most of the piles are so handled because close examination does not disclose hair cracks. While piles are not rejected on account of small cracks caused by stresses which exceed the tensile strength of the concrete but do not exceed the elastic limit of the steel, it is desirable that these cracks be avoided because of the uncertainty of their effect on the protection from sea water.

This method of design, while reducing the amount of steel, is believed to have the necessary strength and factor of safety. At the same time it allows the contractor adequate margin of strength for exigencies in handling, provided instructions are followed as to points of pick-up and the plane to be kept vertical. That these limitations have not been onerous would seem to be indicated by the fact that the contractors frequently drive 25 of these 5-point pick-up piles in an 8-hr. day.

Data used in the design of piles up to 100 ft. in length are shown in the table. In the first column the first figure gives the size of the four corner bars, the second figure the size of the intermediate bars, and the third figure is the breadth of one side of the pile, all piles being square.



STRESS DIAGRAM FOR POSITION OF MAXIMUM "M"

The work is in charge of Frank G. White, chief engineer, State Board of Harbor Commissioners.

Uniform Maintenance Cost-Records for Roads Adopted in Washington

Recent Legislation Having Allocated Sufficient Funds, Also Regulates Their Expenditure and Demands That County Authorities Keep All Primary Roads Up to State Standards

By George F. Cottrell
Chief Engineer, Washington State Highway Department, Olympia

THE State of Washington has advanced its permanent highway construction program on a defined system of state highways and main county routes at the rate of about $5,000,000 annually for the past five years. The fruit of these efforts is now manifest in about 2000 miles of permanent construction fairly covering the main traffic routes of the state. With this mileage of object lessons and contrasts of permanent highways constructed for modern traffic needs public sentiment demands a continuance of this construction program until all main traffic highway routes shall be thus improved.

Provisions for Maintenance Have Lagged

With the advance of road construction programs the problem of maintenance, and particularly of definite financial provision and organization for the care of the investment in supposed "permanent" highways, has moved with lagging steps. Perhaps a more correct expression would be that it has drifted. Washington has probably paralleled the experience of other states in this respect. Highway maintenance has been the subject of more platitudes and less performance, more appeals to the obvious at "good roads" conventions and less action toward the definite between times than any other phase of the highway problem. Lacking the spectacular magnetism of new construction, the drudgery of maintenance fails to attract or hold popular attention. Even with the modern, expensively constructed highways—and perhaps because of their apparent freedom from maintenance needs following new construction—it is hard to break away from the "Arkansas Traveler" rule of repair; the financial provision for railway maintenance is too often a mysterious mixture of guess and politics; while the cost-keeping and accounting of maintenance expenditures has been little more than a volume of vouchers equivalent to a single entry of "spent it all." Endeavor to ascertain from records the actual cost of maintaining a given section or type of highway is usually as fruitless as the answer given by the old watercarrier where lifework had consisted of hauling barrels of water from the river to the arid community near by. A statistician was curious to ascertain how much water had been hauled to the town, and confronted the veteran one day at the riverside with this query:

"Have you ever figured how much water you've hauled out of this river in the last fifty years?"

To which came the prompt reply, "Why, sure, I know exactly how much."

The query being pressed, "Well, how much?" brought the ready answer:

"You see that river flowin thar?"

"Yes."

"Wall, I got the rest of the water."

Which is as sagacious an answer as the average run of highway maintenance "cost records." About all we know is that maintenance money is "water over the wheel" and the roads must speak for themselves as to results—and they usually do!

During 1917 the State of Washington has taken a distinct forward step in the matter of maintenance management and cost records. Although it has come rather by the drift of cumulative legislation than by definite plan, the outlook seems promising.

The legislature of 1913 when making the annual tax levy for $1,500,000 for "permanent highways" to be built and maintained by the counties under state supervision, provided that 5% of this construction fund should be for maintenance of these highways "and other roads of like character." This legislative guess of 5% or $75,000 per year, divided among 39 counties, was expected to maintain the "permanent highway" mileage, increasing each year by 150 to 200 miles. The inadequacy of this maintenance fund became so apparent that in 1915, when license fees for motor vehicles were first levied at rates expected to yield about $150,000 annually, it was provided that the surplus motor revenue, above collection expenses, should go into the permanent highway maintenance fund, thus making a total fund of about $225,000 per annum available for distribution among 39 counties for their ever-increasing mileage. Fortunately the number of motor vehicles increased beyond expectation and in 1916 this joint fund for all counties amounted to $300,000 and was ample to maintain their "permanent highways and other roads of like character."

Maintenance Allotment Increased

In the meantime the system of state highways constructed by the state highway department from the omnibus appropriation of $2,000,000 made biennially by the legislature for thirty to forty scattered projects—about one for each county—were required to be maintained by the state highway department from 5% of their construction fund. This provided $50,000 per year and was reasonably efficient in 1913 and 1914 to maintain the 200 miles of state highways constructed prior to 1913 and to take care of about 300 miles as added during 1913 and 1914. Its inadequacy was, however, becoming so apparent that the 1915 legislature increased the maintenance allotment to 7½%, or $75,000 per year. From this fund the state highway department was required to maintain throughout 1915 and 1916 the constructed mileage of the state highway system, which increased during that period from about 500 to 800 miles. This mileage being in separated sections of 5 to 30 miles each scattered over 30 counties—in most

cases newly constructed roadbed with gravel or crushed rock surfacing and receiving from the outset the heaviest traffic in the state because located on the main traffic highway routes—it became evident in 1916 that the $75,000 annual provision was grossly inadequate for proper maintenance.

Thus the state legislature meeting in January, 1917, was squarely confronted with the problem of maintenance administration and finance; first, for the 800 miles of state highways which were increasing at the rate of about 150 miles per year; second, for about 1200 miles of county permanent highways on main traffic routes under county maintenance administration and likewise increasing at the rate of about 150 miles annually.

Increase Motor Vehicle License Fee

The first decision was to increase the rates of motor vehicle license fees, especially those upon truck tonnage, so that they would yield about 60% more motor revenue and make available an annual maintenance fund estimated at $500,000. The problem was mainly one of proportioning this total between the state highway department and the counties for the respective classes of roads assigned to each for maintenance. The pendulum of legislative deliberation—with perhaps some pulls of politics—swung alternately between the extreme of turning the entire fund and responsibility for all main trunk highway maintenance over to the state highway department for concentrated administration, or distributing the entire fund among the counties and placing all highway maintenance under supervision of the county authorities. In the expiring days of the legislative session the latter extreme was chosen; but in that spirit of compromise which usually marks the progress of democracies, safeguards of state supervision of county maintenance were included in the enactment, which became effective in June, 1917.

Summarized, the Washington maintenance laws now provide:

(1) A county permanent highway maintenance fund held by each county treasurer, paid out only "on vouchers approved by the engineer in charge and allowed by the board of county commissioners, which expenditures shall be for the sole purpose of maintaining and repairing primary (state) and permanent highways or highways of like character and for equipment for the maintenance thereof within their respective counties."

This fund is derived from a 5% allotment of the permanent highway construction fund, or $75,000 annually, to which is added the surplus motor vehicle revenue (over collection expense). In 1917 this provided a fund exceeding $500,000, which was distributed to the 39 counties on the basis of their proportionate payments of state taxation. In 1918 this fund is expected to realize $600,000 and will be apportioned first at the rate of $100 per mile for constructed primary state highways within each county; and the remainder—or about three-fourths of the total fund—on the basis of proportionate state taxation.

(2) A requirement that "all primary (state) highways when constructed shall be maintained at the expense of the permanent highway maintenance fund of the county in which such highway is located." The act further provides that if there is not sufficient money in this maintenance fund, the county commissioners shall expend their permanent highway construction fund for primary state highway maintenance as necessary; and if this construction fund is insufficient or unavailable, they shall provide for maintenance from the general county road and bridge fund.

Thus is enacted—for the first time in Washington maintenance legislation—the fundamental highway principle of maintaining existing roads in preference to new construction where financial inadequacy compels a choice.

(3) "Such highways shall be maintained under such rules, regulations and requirements as may be prescribed by the state highway board."

This short sentence furnishes the key to systematized maintenance administration and records. It is followed by an enforcement provision that "in the event that such highways shall not be maintained in accordance with the standard required by such rules, regulations and requirements, then the state highway board after fifteen days written notice of their intention so to do, directed to the county commissioners of each county, shall cause the maintenance of such highway to be brought up to the standard required . . . ." Adequate provision for payment for this enforced maintenance is made by authorizing state drafts upon the three funds liable for such maintenance, in the order of the liability.

Rules, Regulations and Requirements

The new law became effective on June 7, 1917, and the state highway department was ready for its operation. Rules, regulations and requirements fixing standards and defining the terms and methods prescribed for maintenance were formally adopted by the state highway board and were officially promulgated to the responsible county authorities.

The general system prescribed includes:

(1) A maintenance administration in each county in charge of the county engineer or a special maintenance engineer appointed by the county board of commissioners.

(2) During the closing month of each year the engineer is required to prepare a segregated cost estimate, covering the ensuing year, of the maintenance requirements anticipated for each section of highway in his charge. Each section of a given type of surfaced or paved highway is made the subject of a separate annual estimate and subsequent maintenance cost-keeping. All main highways will thus be covered without combining two types of construction on the same estimate or report.

(3) The engineer's annual estimates are presented to his county board of commissioners for consideration, modification if required, approval and certifying to the state highway department. The state highway commissioner, having before him the county engineer's original estimate and the county commissioners' modifications, may further modify to meet his judgment of adequate maintenance needs. The final result of this triple consideration becomes the advisory budget for each highway section during the ensuing year, and its total is officially set aside as a prior claim upon the maintenance funds, subject to be drawn as required by the engineer

in charge for such maintenance. This approved estimate does not become a legal maximum or minimum of maintenance expenditure, but the full obligation for adequate maintenance up to prescribed standards remains throughout the year, whether the budget develops a surplus or a deficit.

(4) The engineer is required to make monthly reports of actual maintenance expenditures on each highway section, prepared in segregated cost items similar to those used in preparing the annual cost estimates. These monthly reports are certified to the county board and to the state highway department. Thus both county and state authorities will at all times have a record of the relation of current expenditures to the advisory budget authorized at the beginning of the year.

(5) The state highway commissioner is made the administrative and enforcing officer of the state highway board, and particularly "empowered to decide all questions of standards of maintenance which may arise in applying and enforcing these rules, regulations and requirements; also to prepare and publish any forms necessary for such estimates and reports."

It was not deemed wise to attempt preparation of a uniform series of cost-keeping forms for the fractional year following June, 1917. Engineers in the various counties were invited to apply their own ideas of segregation of cost items adapted to local maintenance requirements. Profiting by six months experience and gathering suggestions from the ideas of segregation of maintenance costs presented by the various county engineers, the state highway commission on Dec. 10, 1917, officially published and furnished to the several counties a uniform series of maintenance forms for segregated cost-keeping, estimate and reports. These were prescribed for use throughout the state after Jan. 1, 1918.

Bulletin No. 10, issued Dec. 10, 1917, by the Washington State Highway Department, explains and describes the new system of cost-keeping and records, and particularly defines the terms applied in the segregated itemization of maintenance costs. Four standard forms are provided for the annual cost estimates and the monthly reports of actual expenditures.

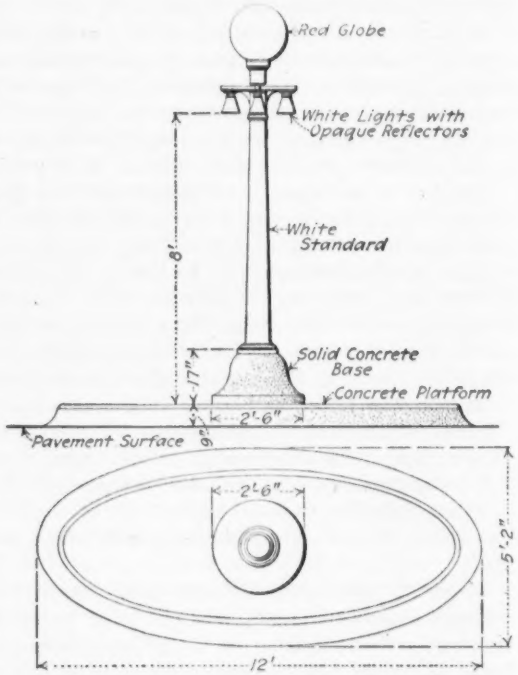
While not considered in any sense a last word in maintenance management or cost-keeping, the Washington system is a definite step forward in a previously neglected field of fundamental public need. As compared with a concentrated system of direct maintenance by the State Highway Department, the combined plan of county administration under state regulation may not tend to the largest public economy. It at least promises results of adequate maintenance, cost what it may, and provides for accurate records of that cost certified by the engineer in charge. While the state highway department cannot command details of organization or compel economy, but only require results and reports, it can give pitiless publicity to comparative cost records which will tend toward efficiency and economy.

When 1918 shall have furnished its complete record of segregated maintenance costs, applied systematically over 2000 miles, including all types of gravel, macadam and paved surface highways, Washington will have some worth-while statistics on maintenance, invaluable for comparisons and future guidance.

Illuminated White Lamp Posts Make Safety Islands Conspicuous

VISIBILITY and strength are essentials in the design of safety islands for busy thoroughfares which make for greater protection against passing automobiles. According to a statement by J. F. Foster, general superintendent of the South Park Commissioners, Chicago, 270 accidents at 153 safety islands occurred in one year. These ranged from the breakage of the electric light globe to the wrecking of autobomile, lamp post and even of the platform.

Painting the island lamp posts white instead of black, in order to increase their visibility, is now practiced in both the South Park and Lincoln Park districts. Even if the island is well lighted, an automobile may skid against it or may be forced into collision with it to avoid striking another car or a pedestrian. The island



STREET SAFETY ISLAND IS DESIGNED FOR STRENGTH AND VISIBILITY AT NIGHT

should be so shaped as to turn aside cars and to effectually stop those which strike it squarely. The platform should be well anchored into the pavement, as otherwise a blow from a heavy car may displace the entire structure.

Shape, color and illumination are points considered in the accompanying proposed design. At night an automobile driver may plainly see a white post and base well illuminated by means of the small white lights, which are shielded by opaque reflectors so that there is no glare. The red-light globe at the top serves as a warning. It is stated that a globe red above and white below, to provide both warning and illumination, has not proved satisfactory. The platform 9 in. high, with a curved face, does not appear likely to serve the purpose of stopping a car that runs into it squarely. For such purpose it would probably be necessary to provide a curb wall at either end of the platform.

Why Some Irrigation Canals and Reservoirs Leak

Unsuspected Subterranean Cavities Cause Settlements When Water Is Turned In—Experiences in Half a Dozen Far Western States Outlined

By A. P. Davis
Director and Chief Engineer, U. S. Reclamation Service, Washington, D. C.

IN NUMEROUS cases the admission of water into irrigation canals and reservoirs has disclosed the existence of subterranean cavities not previously observed. Serious trouble has followed and some reservoirs have been rendered useless. Three notable examples of canal troubles and six of difficulties with reservoirs are here presented, with accounts of the remedies tried and the successes and failures that followed—the latter pertaining more particularly to the reservoirs.

Flathead Canals — On the Flathead Project of the U. S. Indian Service, a series of small canal systems has been constructed, on which bad sink holes and cavities have appeared without previous surface indications. On one system there are 12 such holes to the mile, averaging from 12 to 15 ft. deep and 200 ft. long. On another small system there are about four holes to the mile, which average 6 ft. deep and 100 ft. long. When these canals were constructed the ground was apparently in a satisfactory condition for carrying water, being of stratified clay. In a few places minute cracks occurred in cuts about 3 ft. below the surface, but so small as to be hardly noticeable. When water was turned in these cracks enlarged. In a short time the substrata seemed to melt away and great cavities appeared, absorbing the entire flow of the canal, which disappeared entirely. In some instances by letting the water flow into the holes for a time they would puddle themselves, fill with water, and some repair would restore the canal. In the greater number of cases, however, no such result followed, and after developing the holes thoroughly the water was turned out, the sides of the holes blasted in, and the canal restored by careful puddling, after which no trouble was experienced.

FLOW SOON DISAPPEARED THROUGH LARGE CAVITIES IN BOTTOM OF FLATHEAD CANALS

Many sink holes occurred at the structures along the canal, where the water followed down the cut-off trenches and thus reached the substrata. Such holes are more numerous in cuts that reach the substrata than at other places.

The surface of the country in this region is peculiar in having a large number of potholes many of which form small ponds. These may have been formed by the collapse of underground caverns similar to those described.

Grand Valley Lands, Colorado — In the Grand Valley, on the western slope of the Rocky Mountains, near Palisade, Colo., is a region where the soil, although having no abnormal appearance in its natural state, settles from 1 to 5 ft. vertically soon after becoming thoroughly saturated with water. Farmers making this land ready for irrigation prepare to "settle" in a matter of course way, just as in other regions they clear or level the land. The "settlement" must be performed with care and skill, or great trouble will result. It is necessary to saturate a large area at once in order that the settlement may be as uniform as possible, and not result in potholes and undulations that would be expensive to level. With the utmost care, however, the settlement is often uneven and erratic. This complicates canal construction, making it necessary in building large canals to provide 2 or 3 ft. of extra bank height, lest sudden settlement cause disastrous breaks. Occasionally cracks or cavities develop in the canal perimeter. These give rise to much water wastes and require careful puddling.

Spanish Fork Canal—The main canal of the Reclamation Project, on Spanish Fork River, Utah, showed settlement of from 1 to 2½ ft. in the natural ground in several places, the subsidence appearing several weeks after the canal had been in use for the conveyance of water.

These phenomena occurred on steep sidehills on what was at one time the shore of Lake Bonneville, in material varying from fine silt, sand and gravel to heavy clay containing some small stones. The settlement here seems to be due to the closure of cracks and cavities left by the caving and sliding of the material on the hillside, where the meagre precipitation had never furnished enough water to settle it.

Jerome Reservoir, Idaho—The North Side Twin Falls Irrigation System is built in a country underlain by lava rock through which the Snake River flows

in a gorge several hundred feet deep. Any crevices in the lava, therefore, have ready communication with this deep gorge, and any water in them readily escapes. Numerous springs are in evidence on the walls of the cañon. The Jerome reservoir is constructed on this plain. Its seepage losses are about 0.85 ft. in depth per day, or about what would be expected from a canal in good earth. Holes and fissures in the underlying rock afford the seepage waters ready escape to the Snake River Cañon. The seepage is therefore continuous so long as there is water in the reservoir. The area of the reservoir is 4000 acres and the seepage averages more than 2000 acre-feet per day. This means a loss of over 60,000 acre-feet per month, which is so serious that the reservoir is considered practically worthless.

Many holes developed in the reservoir bottom. These usually started from a badger hole, connecting with a blowhole in the lava, and enlarged until the hole in the lava received all the water it could carry. Most of these holes were less than 6 in. in diameter, but a few much larger ones were found. The smaller holes generally became clogged with moss and debris. The others were dug down to a depth of several feet, then carefully puddled with earth, which usually made a permanent cure of the particular leak. The large loss of water, amounting to 1000 sec.-ft., more or less, was due to the fact that the crevices in the underlying rock would carry off the water as fast as it could filter through the soil. The absence of any water table, permitting the continuance of the seepage in a vertical direction, was the cause of the reservoir's failure. This will be true of any reservoir, no matter how good the soil is, if the conditions permit the seepage to travel on vertical rather than nearly horizontal lines.

Many annoying leaks developed on the north side Twin Falls canals. At such places an excavation to rock was made and the crevice closed with concrete, after which the excavation was filled by puddling. The canal system as a whole now shows fair average tightness.

The Deer Flat Reservoir, Idaho—This reservoir is located near Boise, Idaho. It is formed by joining a series of low hills by embankments and is supplied with water by a canal from the Boise River. It is about 10 miles from the nearest point of the Boise River and its bottom is about 100 ft. above the river. When full it covers an area of 9800 acres and contains 180,000 acre-feet of water. It was placed in service in 1909, when about 60,000 acre-feet of water was run into it, the greater part of which was lost by seepage. Not more than 17,000 acre-feet was in the reservoir at one time, 2500 acres being then submerged. The next year 3900 acres was submerged, and about half of the water was lost by seepage. Many persons believed the reservoir was doomed to failure on account of excessive losses, but subsequent service showed rapid improvement, and in 1917 the seepage losses were equivalent to less than 0.2 in. per day, or about equal to the evaporation.

SEEPAGE LOSSES IN DEER FLAT RESERVOIR, IDAHO

Year	Mean Acreage Submerged	Maximum Acreage Submerged	Evaporation in Acre-Feet	Total Loss in Acre-Feet	Seepage Loss in Acre-Feet	Average Seepage Loss Acre-Feet per Acre	Average Seepage Loss Inches per Day
1909	1,355	2,500	4,750	57,600	52,850	39.0	1.28
1910	3,002	3,900	10,500	95,483	84,983	28.3	0.93
1911	4,459	6,300	15,600	150,838	135,238	30.3	1.00
1912	4,625	7,000	16,200	85,089	68,889	14.9	0.49
1913	5,250	8,200	18,400	89,489	71,089	13.5	0.44
1914	5,337	8,400	18,700	82,084	63,384	12.0	0.40
1915	5,123	8,100	17,900	67,400	49,500	9.7	0.32
1916	4,820	6,900	16,900	43,970	27,070	5.6	0.18
1917	4,500	7,550	11,000	32,400	21,400	4.8	0.16
Mean	4,274	6,540	14,440	78,150	63,820	....	....
Total	38,471	58,850	129,950	704,353	574,403	....	....

The losses during 1909, 1910 and 1911 were less per area submerged than would be expected in a canal in good tight soil, and in the last two years this has been reduced to less than what might be expected from a canal with heavy concrete lining. The steady improvement and remarkable tightness attained are due to the filling of the subsoil with water which cannot rapidly escape and not to any abnormal tightness of the soil.

Lake McMillan, N. M.—On the Pecos River, near Carlsbad, N. M., is a project originally designed and built by a private corporation, in a region in which the country rock is mainly gypsum, or sulphate of lime—a very soft rock easily eroded by water, and to some extent soluble therein. The main reservoir, Lake McMillan, is formed by a dam across the Pecos River and the eastern bank of the reservoir is formed by a gypsum bluff. When the reservoir was filled the water freely entered crevices in this bluff and found ready escape underground. By erosion and solution these openings steadily enlarged and were cut down to the bed of the river, so that they received and carried away the entire ordinary flow of the stream, amounting to several hundred second feet. Numerous sink holes also appeared in the bottom of the reservoir into which the water escaped in considerable quantities. The main leaks, in the gypsum bluff, were excluded by building an earth-and-rock dike parallel to the bluff a distance of about 4900 ft., to a height of 19 ft. The holes in the bottom are puddled from time to time, but not completely cured. The canal system where it traverses gypsum formations was beset with leaks so serious that for some distance the canal location had to be abandoned and the canal rebuilt on a lower elevation. In other places the losses were combated by lining the canal with concrete.

Hondo Reservoir, N. M.—Near Roswell, N. M., is a reservoir formed by a natural depression the capacity of which has been increased by a series of earth dikes connecting the surrounding hills. It is fed by a flood-water canal leading from the Hondo River.

When the reservoir was placed in service considerable leakage was noticed. This rapidly increased by the enlargement of holes in the bottom of the basin, which evidently connected with subterranean caverns. Efforts at puddling these cavities proved unavailing. The leaks continued to increase until a capacity of 200 cu. ft. per sec. was reached and efforts at storage were abandoned.

The country rock in this region is composed largely of gypsum like that which gave trouble at Lake McMillan. This is readily eroded and dissolved and contains water-formed caverns which constitute the seat of the trouble. The depression which forms the reservoir site may be due to the collapse of such caverns. Depressions of this nature are to be regarded with suspicion.

Walnut Cañon Reservoir, Ariz.—In Walnut Cañon, Ariz., a reservoir was built to store water for railroad uses by the Atchison, Topeka & Santa Fe R. R. Co., but although the dam was tight and the earth bottom appeared good, the losses have persisted at the rate of more than half a foot per day over the submerged area—which is sufficient to nearly empty the full reservoir in about seven months and largely destroys its value. The country rock is sandstone and evidently has seams which carry off the water fast enough to keep the water table down.

Tumalo Reservoir, Ore.—This reservoir was built by the state of Oregon in connection with the Tumalo Project. Prior to its construction a board of engineers recommended that it be first built to only partial capacity, and that it be tested for water tightness before heavy expenditures were incurred. It appeared, however, that this would delay completion until the appropriation for its construction would lapse into the general fund. The wise recommendation was disregarded and the dam was completed to its full height. Water was delivered to the reservoir through the feed canal, until it had risen about 20 ft. above the outlet. At this juncture a large hole developed in the bottom of the reservoir about 1000 ft. from the dam, discharging over 200 ft. per sec., which soon emptied the reservoir. This hole was puddled and the water again turned in, but new breaks in the bottom occurred from small cracks to large holes as much as 50 ft. across and from 10 to 30 ft. in depth. Considerable money was spent in puddling these holes. Although the rapid flow through them has been stopped seepage over the whole submerged area occurs to an extent sufficient to render the reservoir worthless.

When the water covered a surface of 30 acres, the observed loss was from 6 to 8 in. per day, which is normal seepage through good earth, but too rapid for storage.

The country rock is of igneous origin and is so fissured that the ground water escapes rapidly to the Deschutes River.

Conclusions—Some of the difficulties encountered, especially in canal building, are of such nature that no method of foreseeing them appears to be possible. In the case of canals, however, these difficulties are usually easily remedied, either by puddling the cavities that appear, as at Flathead and Grand Valley, or by relocation, as at Carlsbad. Remedies in the case of reservoirs are not so easy. Puddling is useless if the subterranean conditions are such that the seepage of water can get away and thus let the seepage continue. No reservoir in earth is of much value if it continuously seeps at the rate that water can pass vertically through puddled earth. The problem then is to avoid regions where subterranean conditions are such that the water can escape. A few rules of caution may be of value:

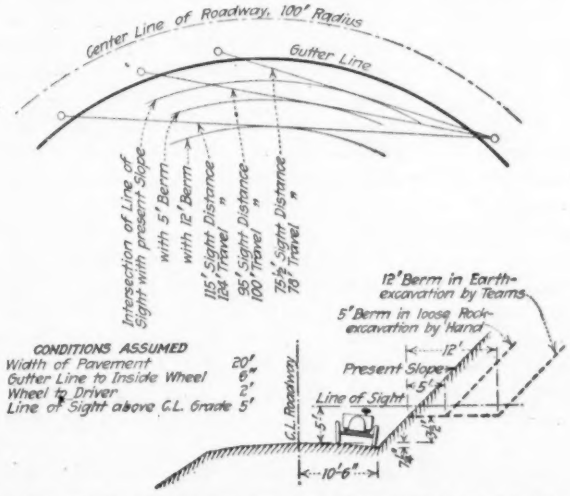
1. Avoid reservoirs adjacent to gypsum deposits and to limestone deposits which show evidence of caves. (2) Examine critically reservoirs in volcanic rock, as a few have failed in such locations. Coarse grained sandstone seems to be an object of suspicion and should be critically examined. (3) Natural depressions are treacherous and should be examined with care, and if they are near deep cañons or underlain with coarse material where water might readily escape, no superficial tightness will avail to make them effective.

Safety Provision on California Mountain Highways

"Day-Lighting" Curves by Cutting Berms To Increase the Distance Drivers Can See Ahead Makes Blind Turns Safer

COLLISIONS on blind curves, the California Highway Commission finds, most frequently result from the fact that one driver, disregarding the law, was cutting the corners and incidentally reducing the range of vision. A plan known as "day-lighting" curves has therefore been adopted which materially increases the range of the drivers' vision around blind curves. This has been extensively used on California mountain highways, where it is believed to have materially increased the safety of travel.

The plan is to excavate a berm on the slope at the inside of the curve beginning at a level of 3½ ft. above the crown of the roadway, which is assumed to be 18 in. below the line of sight for a driver following the inside of the curve. Where the material on the slopes is rock and has to be drilled, berms are made 5 or 6 ft. in width. Where the material is more easily handled



ACCIDENTS LESSENED BY CUTTING BERM ON CURVES

the width is made 12 ft., so that scrapers may be used with the corresponding reduction in cost of handling.

Where berms 5 ft. wide are excavated, on curves of 100-ft. radius, automobiles both on the inside of the road will be in sight of each other when 95 ft. apart in an air line, whereas without the berm they would not be within each other's range of vision until only 75 ft. apart. Where the 12-ft. berm is used the range of vision is increased to 115 ft., or 124 ft. along the line of travel. These distances are considered adequate for safety if the cars are moving at moderate speeds.

The Ridge Route, built by the California Highway Commission between Los Angeles and Bakersfield, traverses a very rough mountainous district and in its length of 30 miles there are about 100 blind curves of 100-ft. radius and four or five less than 100 ft. This road is located in country for the most part so precipitous that the upper sides of cuts are 40 to 60 ft. deep. Any attempt to improve the curvature here by widening

at grade would be prohibitive on account of the large quantities to be moved. However, by the use of the "day-lighting" method, berms have been cut on the inside slopes of all sharp curves which, at comparatively small cost, have increased the safety as much as would the wider grade.

In the maintenance of these roads it has been found that the berms have an additional advantage in their capacity to store material that comes down in small slides, and which would otherwise fill the gutters and thereby cause erosion of the roadbed during storms. Where the slides are caught by beams they can be removed at the convenience of the regular maintenance force instead of being handled as emergency repairs.

Austin B. Fletcher is chief engineer of the California Highway Commission.

The Engineer and the City Plan

A Plea for Engineering Vision and a Story of Failure —Achievement, Opportunity and Needed Legislation at Davenport

MUNICIPAL engineers were urged to see and seize their city-planning opportunities in an address by Roscoe E. Sawistowsky, delivered Feb. 20, before the Iowa Engineering Society. Portions of the address dealing with the subject and also with city-planning projects and problems at Davenport follow:

Engineers are awakening to the fact that municipal engineering today calls for the exercise of a higher judgment, a broader vision, and an imagination tempered with common sense that will enable them to plan wisely for the growth of their cities. The fault with the city engineer is that he has been too intensely absorbed in the problems of more or less precise surveying. He has been content to prepare for the undeveloped portion of the city along the conventional lines followed in the older portions, and has cut streets through regardless of topography, solely intent on extension and enlargement as a checkerboard proposition.

The profession of city planners has been created and filled by noted architects and landscape engineers, due entirely to the fact that the city engineer has not been alive to his opportunities. He has considered himself too busy with the T-square and his book of logarithms to look up and catch a vision of the city of the future; too busy making the city orderly and healthy to consider the opportunity to direct along sane and rational lines the movement to make our cities convenient and beautiful. The municipal engineer, being the first on the ground, is responsible to a large degree for the lines along which our cities will grow and for the ease with which small cities may develop into large ones. The larger part of the problems in city planning so far has been the correction of mistakes that have been made by the engineer through lack of foresight or appreciation of the unsuitability of the plan.

Davenport Street Plan Does Not Fit Ground

The main or business section of Davenport, which extends six blocks back from the river, was well planned. Beyond this the streets were continued to complete the checkerboard system, regardless of deep gullies or hills. Streets were cut through at great cost, making it extremely expensive to fill up the ravines for building sites, and today we have over fifty acres of this unusable property in the heart of the city wholly impossible to utilize except at a prohibitive expense. This could all have been avoided by adjusting the street plant to fit the ground. An excellent example of the application of the correct principles of city planning is the high class residential section known as McClellan Heights.

I have prepared plans and estimates for a traffic way up one of the deep ravines. The construction of this diagonal street could be easily accomplished at a moderate expense. The property immediately adjacent to this ravine is well built up, but fortunately no important improvements have been made in the ravine. The expense of cutting through this traffic way would be justified and the saving in time to the people using it would soon pay for it, if we could apply that method of paying for the expenditure. The distance would be shortened over half a mile. An easy gradient would be possible, not exceeding 4 per cent.

Residence District Restrictions

The last general assembly of Iowa enacted a law giving cities of the third class authority to establish a restricted residence district upon petition of 60% of the property owners residing in said district. We have taken advantage of this act in Davenport. Only last month an oil company was contemplating erecting an automobile-filling station on our main residence street. Upon advice the property owners petitioned that their street be established as a restricted residence district. This was done, much to the consternation of the oil company. At any time the growth of the city should demand it for business purposes the district upon petition of 60% of the property owners can have the restrictions set aside.

We need another law enacted giving cities and towns power to establish building, or setback lines, on residence streets. The establishment of setback lines, or building lines, as they are more commonly known, secures a uniform setback of buildings from the street lines. That is, the owner must locate his building a certain number of feet from the street line. The front of his lot may be used for any other purpose, but he will not be allowed to build upon it.

Excess Condemnation Powers Needed

We need a law giving cities and towns the power of excess condemnation. We are limited in opening or widening any street or boulevard to the precise land needed for the specific public improvement.

In one case at Davenport a street was to be widened by taking 12 ft. off the front of the lot. A house worth $800 projected 2 ft. beyond the proposed new street line. Appraisers allowed the owner damages of $800, the city to take the house and dispose of it at auction. If we had had the power of excess condemnation we could have taken the whole property for about $1000, had the house moved back on the lot at a small expense, and then we could have probably resold the property for more than the cost appraised. As it was, the city paid $800 for the house and sold it at auction for $25 to a man who moved

it onto another lot, the property owner retaining the lot, on which he intends to erect a modern dwelling.

A special effort should be made to have laws enacted by the next general assembly giving cities power to establish a city plan commission. This should be limited to about five members, one of whom should be the city engineer and another the mayor, the law to require that all plats must have the acceptance of the commission before they can accepted by the city or the county and before any lots can be sold.

At present here in Iowa if the owner is unable to have his plat approved by the authorities he can still sell his lots by metes and bounds description. It should be made absolutely impossible for the owner to lay out the lots and streets in his addition any way he pleases, regardless of the streets connecting and the general plan as a whole.

When we get the laws as above outlined I think the city engineer will be able to step into his own and soon give a good account of himself.

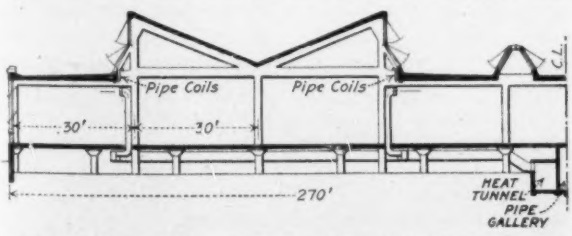
Light and Ventilation Insured in Factory by Unique Roof

Special Form of Concrete Sawtooth Guarantees Air Distribution—Hollow Tile Form Core Inside Roof Slabs

By Nelson J. Bell
Chief Engineer, Schenck & Williams, Architects, Dayton, Ohio.

TWO BUILDINGS recently completed at Morain City, near Dayton, Ohio, are distinguished from the usual type of one-story factory buildings by the completeness of their ventilation and natural illumination and by the contour and construction of their roofs. While the general type of roof-shed to procure the desired ends is not absolutely novel, the use of reinforced concrete was somewhat special and the use of large size clay tile to reduce weight has special interest.

The buildings were designed for the Domestic Engineering Co., makers of Delco-Light farm lighting units. The main building, 270 ft. wide and 1000 ft. long, is intended for machine shop use. The other building, about 100 ft. square, houses the boilers and other equipment necessary for heating the main building. The two buildings are connected by a tunnel, carrying steam and return piping and water mains. No power plant was installed, as the company buys its power from a central station power and lighting company. Both buildings have cellars under their entire areas for the accommodation of piping, heat ducts, etc. The first floor of the main building is of the ordinary four-way flat-slab type, and that of the boiler house is of the beam and slab type. There are no unusual features connected with these floors.



SAWTOOTH ROOF PERMITS PLENTY OF LIGHT AND INSURES VENTILATION

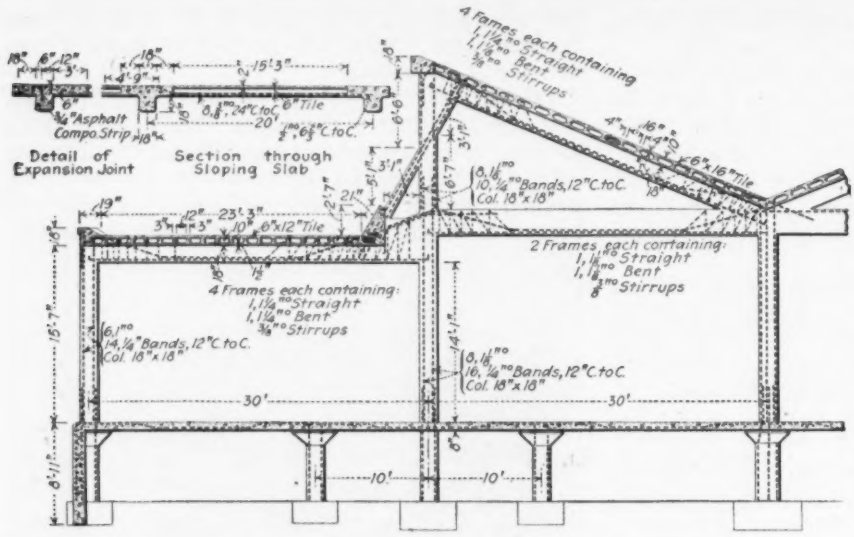
The ventilation and lighting of the main building presented some interesting problems. The building being so wide, it was necessary to provide for daylight and ventilation at frequent intervals between the walls. Ordinary sawtooth roof construction was not considered because of the deficient ventilation inherent in that con-

LAYING HOLLOW TILE FILLERS IN CONCRETE ROOF

struction. The Pond roof construction as exploited by David Lupton's Sons Co., of Philadelphia, was considered but discarded on account of the large amount of overhead dirt collecting, and light-absorbing steel framing. It was desired that ceiling surfaces should be smooth and that all projections interfering with the passage and reflection of light rays should be eliminated. The Pond roof contour was therefore retained and concrete construction was adopted.

The building was divided longitudinally into two units of four 30 ft. bays each, with a central connecting bay 30 ft. wide. Each main unit consists of two side bays with level ceilings, and a monitor two bays wide, with a V-shape roof and top-hung monitor sash in the walls. The connecting bay has two narrow slots in its flat ceiling, over which are A-frame ventilators extending the entire length of the building and equipped with top-hung monitor sash. The outside walls of the building are of narrow brick piers inclosing the concrete columns, the space between piers being filled with side-wall factory sash. Two lines of ventilators, extending through the whole width of the openings, admit air through these side walls.

In summer, ventilation is obtained by gravity, heated air passing out of the monitors and fresh air being admitted through the side wall and A-frame ventilators. In winter, fresh air is heated by steam coils and forced by fans through a system of ducts and reheating plenum chambers to risers at alternate columns on either side of the monitors. This air is blown toward outer walls of the two main units near the ceiling, is cooled by contact with ceiling and walls, returns to the center near


Detail of Expansion Joint
Section through Sloping Slab
4 Frames each containing 1, 1¼"ø Straight 1, 1¼"ø Bent ⅜"ø Stirrups
2 Frames each containing: 1, 1¼"ø Straight 1, 1¼"ø Bent ⅜"ø Stirrups
4 frames each containing: 1, 1¼"ø Straight 1, 1¼"ø Bent ⅜"ø Stirrups
6" Tile
6"×16" Tile
6"×12" Tile
30'
10'

CONCRETE SAWTOOTH ROOF ON ONE-STORY FACTORY HAS BOTH SLOPING AND HORIZONTAL SLABS LIGHTENED WITH HOLLOW TILE INSERTS

the floor, and then ascends and is exhausted through the monitors. This latter movement is augmented by lines of steam coils placed immediately under the monitor sash. A cross-section of the building, shown herewith, illustrates the scheme of ventilation.

The boiler house presented similar problems in regard to light, but the ventilation was easily taken care of by placing a V-shape monitor in the center of the roof, with top hung sash in its walls for the escape of hot air, and full ventilating power-house sash in large windows in the side walls for the admission of fresh air. The construction of this roof was practically the same as that of the roof of the main building.

In order not to interfere with the reflection of light, the ceilings had to be smooth and free from beams running at right angles to the light rays. This was accomplished by using deep slabs spanning the 20 ft. between girders, and by turning up spandrel beams at the edges of openings. In order to lighten the weight of these slabs, and also to reduce condensation as far as practicable, hollow tile were placed in the centers of the slabs, and so spaced as to allow all shearing and compressive stresses to be taken by the concrete. The slabs were 10 in. thick over all, there being 2 in. of concrete on the bottom, then 6 in. of tile, then 2 in. of concrete on the top. The tile used were of special section, being 6 in. high and 16 in. wide, with rounded corners and without webs for the sloping roofs and 6 x 12-in. square tiles in the flat roofs. They were made in lengths of 2 ft. They were spaced to allow 3 x 10-in. webs between the lines of tiles for the flat roofs and 4 x 10-in. webs on the slopes. End tiles were closed by means of a shallow filling of concrete and the ends of rows were kept about 2 ft. from the girder edges to form a T-section, and also to allow the steel to be "trussed up" over the girder.

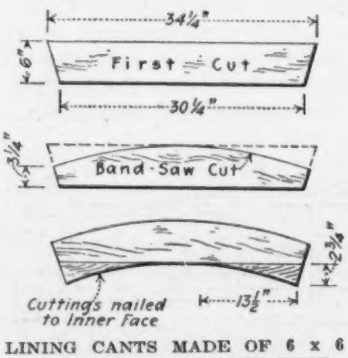
The reinforcement of the girders was composed of several unit frames, each frame consisting of one straight and one bent rod with stirrups looped around and wired to the main rods. The slab reinforcement was laid as in an ordinary solid slab, and equally spaced without regard to the positions of the concrete ribs. Alternate rods were bent up over the girders to resist diagonal tension and stresses due to reverse moment.

In construction, the concrete was mixed rather stiff. The girders were first filled to the bottom of the slab, the 2 in. lower layer of concrete was placed on the slab form, and the tiles were then laid, being held in place on the sloping forms by means of concrete spacing blocks, as illustrated. After the tiles were placed, the ribs were filled and the 2-in. top layer of concrete laid, graded, and floated smooth to receive the composition roofing. Both buildings were built by the Danis-Hunt Construction Co. of Dayton. The architects were Schenck & Williams, of Dayton, for whom the writer is chief engineer.

Protection Table Used on Shield for Sewer Tunnel

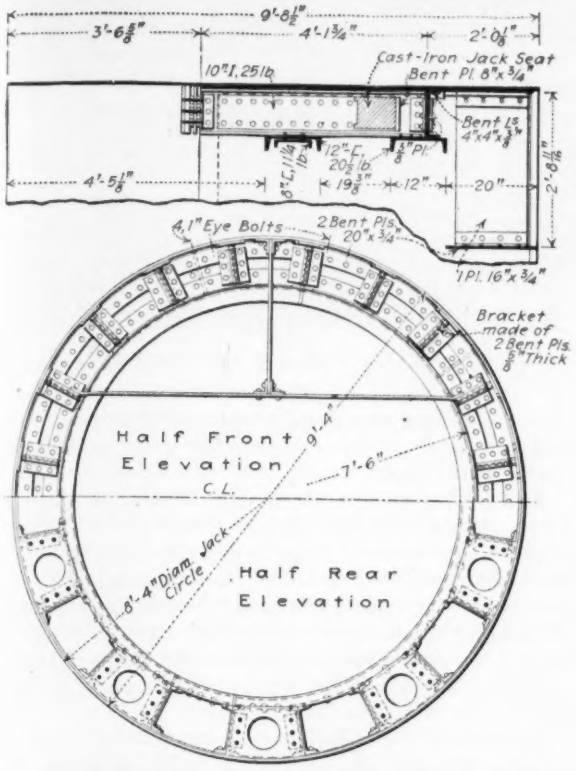
Designed for Constructing Two Miles of Six-Foot Concrete Sewer—Temporary Lining of Timber Cants

TWO shields for driving 11,000 ft. of 6-ft. sewer tunnel at Milwaukee installed by the contractor after having completed 2500 ft. by other methods, have the new feature of a platform or protection table at the upper part of the face. The shields have an exterior diameter of 9 ft. 4 in. and an over-all length of 9 ft. 8½ in. The cutting-edge section is 20 in. long. The shell is made of 1-in. plate to the back of the jack chambers and of ½-in. plate in the tail. The total weight of each shield is 22,500 lb. The driving power is unusually ample, comprising ten 60-ton hydraulic jacks, supplied by an accumulator served by a four-plunger pump. The pressure is 5000 lb. per square inch.



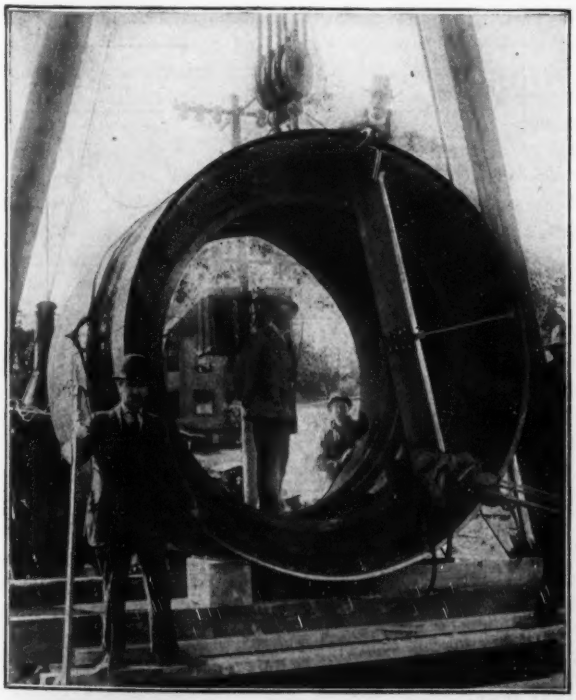
LINING CANTS MADE OF 6 x 6 STICKS; TEN CANTS PER RING

Maple heart cants or segments sawed from 6 x 6-in. timbers are used as temporary lining to hold the ground and take the thrust of the shield jacks. They are shaped in the sawmill of the contractors in the stages shown by the adjoining



SHIELD FOR DRIVING MILWAUKEE SEWER TUNNEL

sketch. Ten normal-length cants are required to the circle; short lengths made from the waste ends of timbers are fitted to place. In making up the cants, the wedge-shaped strips sawed off the outside of the cants are nailed to the inner side, forming a curved face which saves the concrete otherwise wasted in filling out the polygonal contour.



SHIELD READY FOR LOWERING DOWN SHAFT

The finished sewer consists of a 12-in. shell of 1:2½:4½ concrete, unreinforced, of 6 ft. inside diameter. The depth of cover on the tunnel averages 40 ft., with a range of from 6 ft. to 72 ft. The work is for the Milwaukee Sewerage Commission and the Wm. J. O'Brien Construction Co. is the contractor for this section, 13,500 ft. long. The shields were constructed by the Milwaukee Bridge Co. Information has been furnished by Lee G. Warren, engineer for the contractors.

Motor Equipment For Highway Maintenance Work

Light Trucks and Trailers Combine the Advantages of the Patrol with the Economy of the Gang System

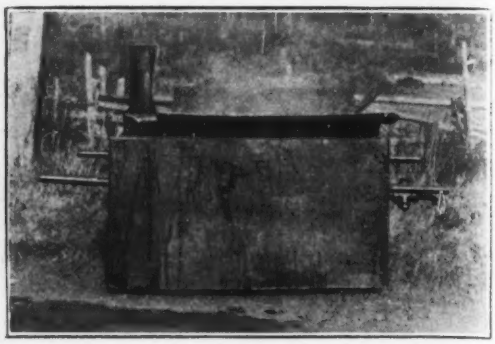
By W. R. Farrington
Division Engineer, Massachusetts Highway Commission, Middleborough

As there has been considerable discussion recently as to the relative efficiency and economy of the patrol and gang system of road maintenance, a system combining some of the best advantages of both patrol and gang systems, now in use in one of the divisions of the state highway work in Massachusetts should be of interest. This system provides for practically constant supervision and quick repairs as does the patrol system, and has also the economy and the possibility of doing more extensive repair work than can be done economically by the patrol men. Incidentally, the "patrol," "contract," "local repair agent" and "gang" systems of maintenance have all been tried at different times on state highway work.

Under the contract system all ordinary repairs were covered by the contract price, but in case of unusual washouts and similar contingencies the actual cost of the additional work was borne by the state. Both patrol and contract systems were satisfactory under conditions prevailing on most of the state highways previous to the advent of the automobile, or where an ordinary water-bound macadam or gravel surface would carry the travel economically.

After the patrol and contract systems were largely given up and before the gang system was generally adopted, much of the work was in charge of local repair agents, who made repairs as ordered from the division engineer's office. Parties with some knowledge of road work and who had, or could readily obtain, teams and laborers were appointed agents.

In handling the repair work at the present time each division is divided into sections with a foreman in charge of all repairs—except resurfacing work, which is done by contract, and certain other resurfacing work requiring considerable equipment, which is handled by a regular resurfacing gang. The foreman is provided with a car having a light truck body, and is stationed at a central point. Ordinarily he drives over the roads once every two or three days; but the sections are so arranged that he can inspect all of the roads in his section in a single day when necessary.



TRAILER CAN HOLD TAR HEATER, WHICH CAN BE REMOVED TO MAKE ROOM FOR OTHER MATERIALS
SIX MEN CAN SLEEP IN THIS TRAILER VAN

The foreman's car can carry 6 men or materials weighing 1000 lb. This enables him to transport men from place to place. In case small repairs are needed, he can take one or more men as well as the necessary tools and materials, thus doing away with one of the chief objections to the ordinary gang system—the difficulty of economically handling necessary repairs when the gangs are working elsewhere.

In each section there are two or three patching gangs consisting usually of from 4 to 6 men. Formerly a single team was used, the equipment consisting of a portable heating kettle, a small mounted tool house—or tool box on wheels—and the necessary tools, usually including a heavy hand roller. At present these gangs are being equipped with the light motor apparatus described later. These gangs do all the ordinary repair work, including the necessary patching of road surface and work on gutters, shoulders and culverts.

The motor equipment consists of a light truck and a trailer with a tar kettle, which is easily removed. When it is not economical to transport the men to and from some central point, vans are being provided in which they can live.

The truck is a light car with runabout seat and a light truck body which is constructed so as to form seats along the sides for the men. It will carry two barrels of oil or tar, or materials weighing 1000 pounds. The trailer body is of metal and is constructed on the same general lines as the truck, so that either men or materials can be transported when the kettle is not in use. The truck and trailer will carry 12 men or materials weighing a ton.

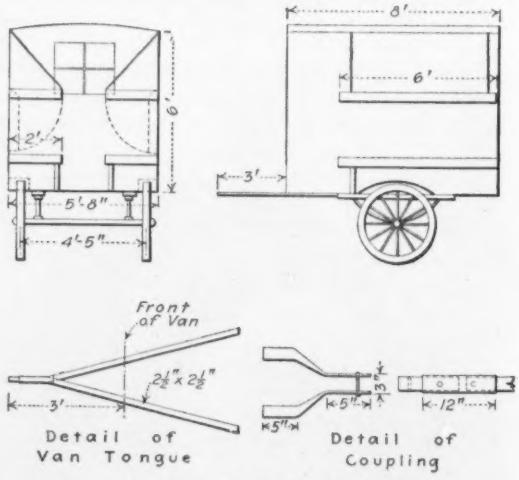
The van is constructed of as light materials as possible and is covered with oiled canvas. There are bunks for 4 men and sufficient space at the front end for an oil stove—which can be used both for cooking and heating—and for luggage. The upper bunks swing back so that the lower bunks can be used as seats. The truck, trailer and van have 30 x 3½-in. pneumatic tires, thus avoiding the necessity of carrying several different sizes of shoes and tubes.

While intended for only four men, the van will accommodate six men temporarily by stretching heavy canvas between the bunks.

On the first trucks no change was made in the gear ratio regularly furnished by the manufacturer, but 4 to 1 driving gears have been installed in the more recently acquired trucks—the lower gear ratio resulting in increased power and reduced speed, but allowing as high a rate of speed as is probably advisable with an outfit of this kind.

Aside from the cars or light trucks for the foremen, the equipment described was first used in 1917 and of course under unusual labor conditions. But while, on the other hand, the difficulty of obtaining competent laborers was a handicap in inaugurating a new method of handling the work, the system has certainly proved a success and it has been possible to keep the roads in the sections covered in better repair and at a less cost than would otherwise have been possible.

For heavier work heavier trucks are without doubt advisable, but for the particular work described the writer believes the outfit used is the most economical and efficient. Some of the advantages are low first cost and very reasonable cost of upkeep. The pneumatic tires not only save time in transporting men and materials or in moving between jobs, but also save wear



DETAILS OF TRAILER VAN

and tear on the outfit, which of course affects the maintenance cost.

By using the light units the dead weight is kept at a minimum at all times. When the kettle is in use on patching work, the trailer and kettle can be detached and the truck used to bring up bituminous or other materials without delaying the work, since the trailer and kettle are light enough to be moved short distances by the men.

Experiences with Imhoff Tank Foaming Told by Sewage-Works Operators

Engineers and Chemists at Fitchburg, Schenectady, Rochester, Atlanta and Columbus Sum Up Difficulties, How Overcome, and Give Opinions as to Causes—Good Sludge Digestion and Removal of First Importance

[*Foaming in Imhoff or two-story sewage-settling tanks, requiring strenuous efforts to prevent most troublesome overflow of scum through gas vents, has been the experience of many sewage-works operators, especially soon after the tanks were first put in operation. Experiences with foaming up to the autumn of 1917 have been sent by request to* Engineering News-Record *by the operators of sewage-works in five cities and are printed below. At Fitchburg and Rochester foaming has given but little trouble, but at Schenectady, Atlanta and Columbus the contrary has been true. Raising gas vents slightly was of material assistance in preventing overflows at Schenectady, but an 8-ft. extension at one of the Atlanta plants was of no avail. Gas-vent extensions, playing water onto the scum or stirring with poles, are palliatives at best. Foaming should be prevented by the removal of well-digested sludge and scum and by giving care to other operating details.—Editor.*]

No Persistent Foaming at Fitchburg

By Frank Woodbury Jones
Supervising Chemist

THE Imhoff tanks at Fitchburg, Mass., were put in operation Oct. 15, 1914. No persistent foaming has occurred up to the present time and only three cases of temporary foaming, two in Tank 1 and one in Tank 5, have been noted.

On Aug. 2, 1915, Tank 1, which had been in the continuous use and had had some sludge withdrawn, became very active and a sludgy, boiling froth, which appeared first in one row of chimneys, rose to a maximum height of 4.5 ft. above the water level. The average specific gravity of this froth was found to be 0.360. No frothing occurred in the side vents. Sludge from the secondary or post-filter tanks had been admitted to this tank July 23 to 28, and the weather during the week prior to Aug. 2 was very rainy and muggy. The depth of sludge in Tank 1 when the foaming began was well within the allowable depth of 10.5 ft., there being only 4.42 ft. previous to the admission of the secondary tank sludge. Tank 4, which was operating in parallel with Tank 1 at that time, contained about 3 ft. more sludge, but showed no signs of unusual activity. On Aug. 3, on account of repairs in the siphon line, it was necessary to shut down the plant for ten days. Tank 1, however, was not used again until October and then all trace of foaming had disappeared.

During June, 1916, foam rose 18 in. in the east row of the side vents of Tank 1 and spilled into the sedimentation chamber. Turning a hose on the froth had no permanent effect, but when sludge was withdrawn the foaming ceased. Again, on Aug. 9, 1917, after a week of exceedingly hot weather, foaming was noted in some of the chimneys of Tank 5. The sludge compartment, as in the preceding case, was full to the slots. After withdrawing 2 ft. of sludge on Aug. 11 the foaming subsided and the operation of the tank became normal.

It would appear that wet muggy weather, when the barometer is low, is most favorable for foaming and that a tank filled with sludge to the critical depth is most susceptible, although foaming may occur when the sludge depth is not excessive. Withdrawal of sludge or a temporary lowering of the tank level to reduce gas pressure may afford some relief in cases of incipient foaming.

Gas Vents Raised and Well-Digested Sludge and Scum Removed at Schenectady

By Earl Devendorf
Assistant Engineer-in-charge of Sewage Disposal

THE sewage-treatment plant at Schenectady, N. Y., consisting of Imhoff tanks and sprinkling filters, was put in operation Jan. 12, 1915. During the winter there was very little gasification in the digestion chambers.

In June, 1915, the first sludge was drawn. It was coarse, brown, had a very offensive odor and was acid.

To correct the acidity, from 100 to 400 lb. of lime was introduced into each tank. Almost immediately thereafter large volumnes of gas were given off and about the middle of July much foam arose in the gas vents and overflowed the walls into the sedimentation compartments. The freeboard of these tanks was only about 9 in. In an effort to prevent the tanks from foaming over, the scum in the gas vents was broken up by hose streams applied daily, and sometimes more than once each day. When conditions were worse, fermentation was so active that the tanks would foam over within a very few hours after the scum had been driven down by the hose streams. Upon the advent of cold weather, the foaming gradually decreased and finally ceased. Whether the active fermentation immediately following the introduction of the lime was due to the lime or to the advent of the warm weather was not entirely clear, although it seems likely that the latter condition was the more important.

During the spring and early summer of 1916 foaming continued as in 1915. Lime was again introduced and almost immediately stopped the foaming, although it did not stop the evolution of gas. An examination of the sludge, however, showed it to be exceedingly offensive, and it became evident that the lime was unfavorable to a satisfactory digestion of the sludge.

In the summer of 1916 the gas vents were raised about 14 in. by means of plank boxes. This greatly reduced the labor necessary for hosing the scum to prevent the tanks from foaming over.

During the summer of 1917, foaming appeared, but

with the aid of the plank boxes it did not assume any serious proportion, although if the quantity of sludge and scum within the tanks is not properly controlled the foam passes over the raised gas vents.

The cause of foaming at Schenectady is unquestionably the overloading of the very shallow digestion chambers and the consequent intensive fermentation which goes on during warm weather. This fermentation is no doubt more intense on account of the low temperature of the sewage, due to the use of ground water. This has the effect of shortening the warm season, during which fermentation is very active, and necessitates the digestion of the large quantity of sludge accumulated during periods of low temperatures.

The foaming over of the tanks has been substantially stopped by the frequent removal of sludge from the digestion chambers and of scum from the gas vents. At Schenectady the scum may be removed by drawing it off onto the sludge beds through the sludge pipe, the riser of which terminates about 16 in. below the top of the wooden boxes.

The success in dealing with foaming at Schenectady is due to raising the gas vents and to the proper removal of well digested sludge and scum.

Raising Atlanta Gas Vents of No Avail, But Foaming Always Stopped Somehow

By Charles C. Hommon
Chemist in Charge

IN AN effort to control foaming in the Imhoff tanks at Atlanta, Ga., I tried building one of the vents at the Proctor Creek plant high enough to retain the scum. As I remember, I built it up some 8 ft. The foam ran over the top of it, so I gave up the idea as a bad one. It is my personal opinion that the only way to relieve this trouble is to remove the cause. Just what the cause is I am not able to state definitely. We have always been able to stop our foaming by some means, such as drawing sludge, stirring the sludge with water under pressure, putting the tank out of commission for a short time, changing sludge from one tank to another, but have not found anything that will work in all cases. I feel sure there must be some remedy, but thus far I have not been able to lay my hands on it.

[Notes on raising the gas vents may be found in the 1916 report of the American Society of Municipal Improvements, p. 467.—Editor.]

Sludge Removal Indicated as Primary Means of Foaming Control at Columbus

By C. B. Hoover
Chemist in Charge

ONE-STORY settling tanks were in service at the Columbus sewage-works for seven years, 1909 to 1915, inclusive. In 1915-17 these tanks were changed to the two-story type. During 1916 and 1917 completed two-story units have been in service and considerable trouble has been occasioned by foaming from the gas vents. The impression seems to prevail that this phenomenon is distinctive of the two-story type of tank, but our experience leads us to believe that the gas vent of the two-story tank has merely made more manifest certain tank-treatment activities which occur in the one-story tanks also.

Our experience with the one-story tank indicated that good clarification could be maintained for from four to six weeks in warm weather, after which the effluent from the tank would begin to show a higher suspended-matter content and the deterioration in the quality of the effluent would continue until the tank would become useless as a clarifying device. Under such circumstances the tank liquor would be noticeably blacker than the untreated sewage and the active production and release of gas would result in large volumes of sludge being lifted to the surface.

The foaming from the gas vents of our new two-story tanks has appeared in from four to six weeks from the time the tanks were placed in service. This leads us to believe that the cause is identical with that which interferes with the clarifying function of the one-story tank and that the gas vent of the two-story tank simply accentuates the trouble.

We believe that the trouble has its source in the bottom sludge, which would be the oldest and most advanced in decomposition, and that if a sufficient volume of this highly gas-charged sludge is removed at the right time the foaming can be practically obviated. The problem, however, is probably not as simple as this statement would indicate, and in order to prevent foaming and also to discharge only well-digested sludge on the drying beds, other factors may have to be considered, such as a proper adjustment of the rate of flow through the tanks.

No Foaming at Rochester—Scum Broken Down as Soon as Observed

By W. A. Bantrell
Engineer and Chemist

THERE has been no foaming at the Brighton plant of Rochester, N. Y., which was put into operation Mar. 1, 1916, nor at the Irondequoit plant, which has been in operation since March, 1917. At both plants, however, there has been scum or sludge rising in the gas slots, but this was not permitted to accumulate.

[Details of foaming and other experiences on starting up the Imhoff tanks at Columbus were given by Mr. Hoover in *Engineering News-Record*, May 31, 1917, p. 447. An article on foaming troubles at Dallas, Tex., by Charles Saville and R. H. Gould, was printed in *Engineering News-Record*, Dec. 6, 1917, p. 1067.—Editor.]

City Managers Exchange Information

In accordance with a plan agreed on at their last convention the members of the City Managers Association (H. G. Otis, secretary, Beaufort, S. C.) are receiving monthly a paper written by one of their number dealing with city manager problems. The first of these papers is by C. A. Bingham, city manager of Norwood, Mass., for the last two or three years, but just chosen manager of Waltham, Mass. Mr. Bingham's paper deals first with the importance of having a municipal highway program, then outlines a five-year highway program adopted by Norwood in 1915, under which $140,000 of $200,000 proposed expenditure has already been carried out.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

The New Era and Engineers

Sir—You have pointed out the way. In the front page editorials of recent issues of *Engineering News-Record* you have opened up a new line of thought for engineers—and to start an engineer seriously thinking along a definite line, with a worth-while objective, invariably means an answer at the end. We cannot conceive of its being other than the correct answer.

May we say that it is the accepted time for earnest thought, at least. It is the eve of the day on which engineers will come into their own. This fact cannot be doubted.

The problems which you are presenting so ably are, as you say, deep seated. Anyone seeking the process of solution is given no accepted formula in which known values may be substituted, no "good practice" has been laid down, nor can he turn to the "answers" and check his result. Yet after all there are known quantities, elemental ones, and any solution which fails to apply justice, plain human kindness (or may we say neighborliness and perhaps a little charity?) toward institutions which are the result of the system rather than the acts of individuals who have contributed to the system, must fail to produce the answer that will stand the test. The factors which have brought about a condition bordering on a crisis, which at the present moment is merely held in abeyance pending the vindication of our very right to exist as a self-governed people, are so involved, are such a tangled mess of thoughts, words and actions of a shortsighted and selfish humanity, reaching back so far into the past that no scheme hastily prepared or half-heartedly applied can obtain a lasting remedy.

The failure of the present arrangement is apparent; the causative facts are obtainable and a solution is possible. Engineers have solved big problems before, and even though this one is somewhat out of their usual line of endeavor, a great opportunity is presented here—a chance to increase the scope of the profession so that it may more nearly assume its proper proportions. Surely engineers will not fail in this, by far the biggest chance to serve mankind by properly directing the force of "human nature."

I have been greatly interested in these editorials and the letters of comment. It seems to me that you are reaching all engineers, but especially the younger fellows who have the future to face, who have not yet lost that certain fire of enthusiastic idealism which is so often obscured by the mellowing process of maturity and the settling down to a sort of contented conservatism. But this is a job for both young and old. And even the young chap in the most obscure capacity may have a good idea—all can help.

Let every engineer apply to the consideration of the human forces and their interrelations—which play such an important part in the actual completion of the thing which he conceives, designs or constructs—the same acumen which he now employs in working out the details of his material plans. Let us not only deal with things but also with people.

You, sir, have entered the wedge. I wish to congratulate you and urge that you do not cease driving it deeper now that the way is opened.

H. W. SKIDMORE,
Construction Engineer, Department of Public Works.
Oak Park, Ill.

Mill Buildings and Laminated Floors

Sir—Allow me to compliment you on the display cover used on the Dec. 27, 1917, number of *Engineering News-Record*, also upon the very complete article on Mill Construction Buildings by F. W. Dean, which was printed in that issue. I recognized the cover design as a picture of the Wood worsted mill at Lawrence, Mass., and understand that this is the largest plant of its kind in the world. This building stands as an example of extra large floor areas which have been made fire-safe by proper handling.

An article of this kind coming from such a well known engineer as Mr. Dean is without doubt a standard and represents conservative practice in mill building design. While the details which he described vary considerably from those used in sections of the country outside of New England, the basic principles are the same as used throughout the Middle West. I believe that the use of pintles between columns is almost entirely confined to the New England states, but do not doubt their effectiveness as described by the article. It is difficult to make engineers of the Middle West recognize their value, since their experience has not warranted the added expense of this type of construction.

The current practice in this section of the country is to allow the posts from each floor to rest directly upon the post cap of the floor below, butting the girders against the post on each side at the cap. The objection to having the ends of the girders rest upon brackets on the caps which project beyond the line of the column below is very logical, but experience here has not shown that such construction is dangerous, especially where sprinkler equipment is provided.

Again, the use of metal hangers or stirrups is objectionable due to the effects of fire as stated by Mr. Dean, but local engineers depend on the efficiency of the sprinkler system to prevent such failures. We have recognized this point in our Engineering Bulletin No. 2 on "Heavy Timber Mill Construction Buildings" and have advised placing beams on the top of girders as suggested by Mr. Dean in his paper.

We notice that the term "longleaf" yellow pine is used in two or three places in the article and wish to call your attention to the fact that the terms "longleaf" pine and "shortleaf" pine, etc., have been superseded by a new classification in which Southern pine structural timbers are graded as "dense" and "sound." It may also be well to note that the new requirements for select structural material call for at least 85% of heartwood, girth measurement, measured anywhere in the length of the piece.

Mr. Dean condemns the use of laminated floors in

mill buildings, but our experience in the Middle West has shown them to be very satisfactory. They permit the use of wide bays and heavy loads, and at the same time provide smooth, flat ceiling spaces with good light and free from members forming small panels or pockets. There are many buildings in this section of the country in which this type of floor has been used with good results, especially where extremely heavy loading is to be carried.

A strong and stiff floor will result if planks 2 or 3 in. thick and 6 or 8 in. wide, depending on the amount of load to be carried and the length of span, are laid to butt over the girders, with one plank laid across the girders at frequent intervals (every sixth or eighth piece) to act as a tie in the floor. Another method is to have the ends of planks join at or near the quarter point of the span between girders, taking care to break joints in such a way that no continuous line across the floor will occur.

In laying laminated floors it is advisable to omit the last two planks at walls until after glazing and roofing have been completed. Then these spaces should be filled in close against the walls. General practice in this locality recommends that laminated floors be laid without nailing to the girders which support the floors, so that expansion in the floor, due to dampness, will not cause movement in the girders at the walls. The material for laminated floors is surfaced on four sides and the corners beveled to provide a finished appearance to the ceiling on the floor below. In laying, the pieces are spiked together at 18-in. distances with 60-penny nails. This main floor is covered with a 1-in. finished floor of hardwood or edge-grain softwood.

C. G. PAUL.
Construction Engineer, National Lumber Manufacturers Association.
Chicago.

Why Not Double-Decked Streets for New York City?

Sir—The New York daily papers have been giving publicity to a proposed solution for the relief of traffic on Fifth Avenue, New York City, between 40th and 59th streets. The writer refers to the plan proposed by Dr. J. A. Harriss, fourth deputy police commissioner, in charge of traffic. Briefly, this proposal consists in the widening of the present elevated structure on Sixth Avenue, between the streets mentioned above, so that provision would be made at the elevated level for pedestrians and light vehicular through traffic. This would in effect transform the Sixth Avenue street level into a subway given over to heavy trucking, street cars, and local traffic, and would force all the adjoining business houses to raise their entrances to the new level. The object of relieving Fifth Avenue would be attained in that much of the traffic on that thoroughfare, being through traffic, would naturally flow to the new elevated street which would offer a clear way through the heart of the shopping district.

The writer not only wishes to commend this solution of a problem which is very vexing, but wishes also to congratulate the city on having as one of its servants a man who has enough vision to see that the rearranging of traffic rules, increases in efficiency of the traffic squad, and the removal of a few obstructions here and there, while good in themselves, do not settle anything finally. New York will have to inaugurate a plan of broad scope and one calculated to serve the future as well as the present, else the business life will be throttled. It is this broader view that the writer wishes to bring to your attention.

During the past winter we have felt severely the effects caused by allowing our railroads to lag ten years behind our industries in their development. We are beginning to see also the effect on the nation, and New York as well, of a harbor which, while second to none in natural advantages, is also underdeveloped at least ten years. Our highways, as you have repeatedly pointed out, are also deserving of extension and improvement. In short, we have begun to recognize that our natural facilities for transportation must come in for serious thought and extensive improvement, not only as a measure of good business but also for the sake of the security and comfort of our country. The question then is, will New York City fail to apply this lesson at home? Will New York City continue to listen to the self-seeking clamor of groups here and there, applying courtplaster as each new eruption occurs, or will she seek the source of the infection and apply a comprehensive remedy? Will New York City plan and act in a broad way for the years to come?

These thoughts occur to the writer for the reason that he considers, and indeed has long felt, that Dr. Harriss' method of relieving Fifth Avenue is generally applicable. The writer believes, and is willing to say at the risk of appearing fantastic, that the time will come when a very large portion of the island, most of it, in fact, from 59th St. to the Battery, will contain two street levels, just as Dr. Harriss proposes now for Sixth Avenue. Does it require too much imagination to conceive of all lower New York with clean, wide unencumbered streets at what is now the second-story level, given over to pedestrians and light vehicles, and the ground given over to heavy vehicles, rail-transit and pipe galleries? In other words, light traffic above; freight and through traffic below. Is there any real estate man who cannot see enhanced value in this?

To give an idea how narrow are the views frequently expressed on this question of traffic, one only has to read the comments on Dr. Harriss' plan. Most of the tenants along Sixth Avenue object to the shutting out of light and air forgetting they would have more than they have now by cutting a new doorway a few feet higher. Others propose more subways, forgetting two miles of elevated structure could be built for one mile of subway and in one-quarter the time and with one-tenth the disturbance. Others propose having the city divided into zones, all business men and workers being required to go to and from business at stated times so as to spread the load on our transportation facilities over greater time. It hardly seems possible that any one could make such a suggestion seriously, but along comes a lawyer who proposes that each employer release his employees in groups, say one-fourth of them at five o'clock and the balance in quarters at 15-minute intervals. In other words, it is proposed to make our life and business conform to our streets instead of arranging our thoroughfares to conform to our purposes.

It will of course be said that the cost of the general application of Dr. Harriss' plan would be too stupendous to consider, but is such the case? Naturally such a plan could not be executed over night. The plan is the thing and this should be worked out completely first. Then street after street should be constructed in accordance with the plan. Elevated structures cost less than subways. An elevated structure of the sort proposed would make a subway at the same time and one which would handle more than people. Freight could be taken by power from terminal to doorstep. Many of the pipes, now being continually dug up for repairs, could be located at the ground level where they would be constantly accessible. Street surfaces on the top level designed for light traffic would not be torn up by trucking, as is now the case. Snow in winter would not obstruct trucking nor the rapid transit of people, all being on the lower level. The possible saving in human life by a system which segregates traffic by classes is self-apparent. These and many other considerations which space does not permit enumerating would mean reduced annual expense, a settled state of affairs, and increased municipal efficiency. If this cost were spread over the next two generations it could be handled.

At present the plan is the thing. Something to work to so that as each part is completed we may feel it is once and for all. The writer hopes that *Engineering News-Record* will advocate good roads for New York as energetically as it has done for the country as a whole, and in so doing that the plan will be a broad one —if not that here proposed, then a better one.

New York City. C. S. RINDSFOOS.

Use of Minimum Stream-Flow Records

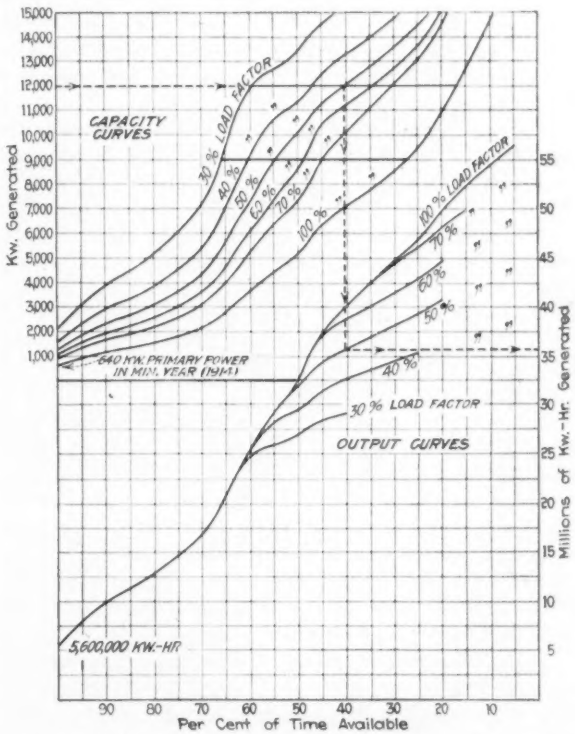
Sir—Under the caption, "Common Use of Records of Minimum Stream Flow Is Pernicious," in your issue of Feb. 21, George F. Ladshaw has made some misleading, if not altogether erroneous, statements which ought not to pass without discussion. The subject is such a large one that the writer will not attempt to comment on other than a few of the essential points.

Mr. Ladshaw apparently premises his statements upon the idea that many water-power developments are installed utilizing water only up to the minimum flow. The writer cannot recall a single instance in his experience of twelve years in this line of work where such has been the case, although there may be rare instances which could be cited. Therefore, he does not believe the practice is a common one.

There are two important rates of flow that ought to be determined as definitely as may be possible for every water-power development. The first is that flow to which it is the most economical to develop, which determines the size or capacity of the plant. The second is the minimum flow which Mr. Ladshaw believes has been so misused. The two are interdependent, as will be explained.

There is really no fixed method for determining the size of an installation for a water-power plant, nor in fact is there really any such thing as an economical plant capacity. The best size of plant to install depends not only on the stream flow available (the supply of raw material), but also upon the market conditions (the amount and value of the manufactured product). Consideration of the market conditions alone requires a study of operating-load factors, involving the amount of storage and pondage available, combined with a study of the use which is to be made of the power and the average rates to be obtained from its sale, or value to the user. Obviously there are many variations in the "power equation," if we may call it such, and the size of plant which seems economical today may not prove so at a future date.

Expressed in another way, it should be evident that to determine the proper size of a plant involves assumptions not only as to the probable behavior of the stream



HYDROELECTRIC CAPACITY AND OUTPUT CURVES COMPARED

Based upon stream-flow records for the year ending July 10, 1913, which was nearly typical of an average year. The curves show theoretical power available, with no allowance for utilization factor or factor of leakage and waste of water in operation. Capacity curves are similar to the well-known duration-of-flow curves, a 100% load factor corresponding to run-of-river power.

in the future, but also as to the manner of utilizing the power, and of its value as determined by combining the expected needs of the various customers, or departments of an industry. This broad statement applies equally well to the diversified public service company's load and to the private industry which always has its more or less variable needs. All assumptions represent the investigator's opinion of what may happen in the future as based upon a study of past events.

In reality, we ordinarily determine as nearly as we can what are the immediate conditions which affect capacity and use of water, and if we are wise, reserve room for expansions as the need arises. This means also that care should be exercised lest capacity be chosen that the future will not show there has been an overdevelopment—too much optimism. It is less expensive to add to a structure than it is to pull out and waste that which has once been put in place.

If we make the customary study of the economics of the case, we must distinguish between that power which may always be depended upon and that which is available for a portion of the year only; or perhaps that which is available for an entire year under good flow conditions, but not at all during especially dry years. This involves a consideration of the absolute minimum flow as well as the dependable minimum in an average number of years.

Mr. Ladshaw states that "the sequence of wet, dry and normal is mere chance." The fact that a minimum flow has already occurred, perhaps within a comparatively few years, would not warrant our ignoring that fact, and the possibility of a re-occurrence within the life of our plant. Especially is this true when one is recommending the expenditure necessary for making a development involving vast sums of money.

The absolute minimum flow is of value in determining the dependable water-power available, and in addition furnishes a guide as to relay requirements when it is essential to furnish more dependable power than that corresponding to the minimum flow of the stream. How much chance of a repetition or recurrence of minimum flows can be taken, and consequently how much the absolute minimum can be discounted, depends entirely upon the purposes for which the power is desired and how it would affect the business of the user if his requirements could not be met.

Any study of the history of the minimum flows on a river should include the question of whether these minima are in any way the result of artificial regulation upstream and to what extent such control, if any, would affect the power available. The fact that a minimum has occurred, whether it is the result of any upstream regulation or not, should ordinarily not be discounted, because there is no assurance that in the future the same controlling circumstances may not occur again.

As an illustration of the foregoing, a diagram is submitted from an actual investigation, which has since been well borne out by the operating data at the plant. Suppose it were desired to relay this plant by steam up to a 12,000-kw. capacity. The steam capacity required would depend upon the load factor at which the hydraulic plant could operate at times of minimum flow. As a general principle, the adjustment of the load between a hydraulic and a steam plant should be such that the former operates at a low load factor (i.e. at times of peak load) during periods of low water and changes over to a high load factor (i.e. operates as a base load plant) as flow conditions permit.

In the illustration let us assume a 30% load factor on the hydraulic plant at time of minimum flow. If the diagram is based upon the absolute minimum flow available (corresponding to 100% of the time available) it can be seen at a glance that the steam plant must have a capacity at time of maximum load of 12,000 less 2200 or 9800 kw. This does not represent the economical size of the steam plant but does give its maximum load. Its size will be something less, since its machinery can be overloaded heavily at a time of emergency, and since it is dependent also upon the shape of the daily load curves.

The balance of the hydraulic capacity curves are based upon flow conditions in an average year. The average steam output to be expected may be computed directly and is represented by the area to the left of the proper load-factor curve. If the basic data permit, the writer ordinarily determines a variable load-factor curve, starting at the lower left-hand side of the diagram with a minimum load factor on the water-power plant and crossing the curves shown to a maximum load factor in the upper portion of the curves. The area does not, in this latter case, represent the steam energy, but it can be determined by a few simple calculations.

The "tails" on the output curves are the result of insufficient pondage and storage, and indicate where waste of water begins. These curves are for a specific case and will vary in detail for different investigations. For example, widely varying head relations will necessitate an entirely different type of diagram. To the writer they indicate clearly the importance of minimum, as well as average, flow determinations.

Mr. Ladshaw also refers both to the use of rainfall in determining run-off, and the method of determining run-off from homologous basins. Both methods are exceedingly dangerous and should not be used except as a last resort, as evidenced by any careful study of the available government run-off records and by recent engineering discussions.

The whole subject is too involved to permit of a simple presentation in a few words. For those who care for a more detailed outline of these problems, reference may be had to the writer's paper, "Power Estimates from Stream Flow and Rainfall Data," presented with discussions in the *Journal* of the Boston Society of Civil Engineers for March and June, 1916.

Boston, Mass. DANA M. WOOD.

Engineer Officer Runs Town in France

The kind of work that some of the Engineer Reserve officers have to tackle in France is indicated by a recent letter received in this country from Capt. John F. Osborn of Boston who writes:

"I have had charge of two companies of the regiment practically since I landed in France. We have been doing a large amount of construction work under trying conditions. We have been building what amounts to a small town, with water-works, sewerage system, electric lighting, etc., and I have had to be mayor, chief of police, fire department, judge, court and all. I have had under me nearly a thousand men, and it is really some little job to look after the food, clothing, medical attention and all. I have quite a contractor's organization worked up which would be of considerable value to some contractor if it could be turned over entire. Osbornville, as the men have called this division of the landscape, has grown very fast.

"The regiment got together for review the other day and it certainly made a fine appearance. The band, whose instruments were paid for by the Boston Society of Civil Engineers, is certainly a fine addition, and is much appreciated by the men. The generosity of the society made it possible to give these hardworking boys the pleasure of listening to and marching to the martial tunes we love so well. An engineer regiment is not allowed a band, but the help of the society was such as to give the boys something which would have been greatly missed."

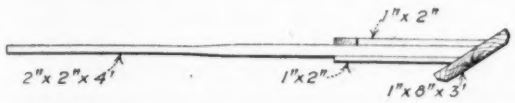
HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Finish 3325 Sq.Ft. of Concrete Floor for 58c. Per 100 Sq.Ft.

By JOHN T. SULLIVAN, C. E.
Roos Bros. Construction Co., Cincinnati

A UNIT cost on concrete floor finishing of 58c. for 100 sq.ft. was recently attained on the first floor of the new Charles Shannon Building in Cincinnati. The entire job, consisting of 3325 sq.ft. was cleaned up by four laborers and two finishers within nine hours. Work started at 7 a.m. Two laborers mixed the finishing material—one wet batch and another dry batch—using



iron mortar boxes. Two other laborers roughened the floor with wire brooms, the floor having been poured the previous day. As soon as the first batch was ready, one of the laborers was used to wheel the finish in on the floor.

One finisher spread the batch while the second finisher leveled it off with a 6-ft. screed. The first finisher then floated the surface with a long home-made float and with a hand-float. The second finisher then spread and screeded continuously while his partner worked on floating. At 2 o'clock the whole floor was spread and screeded, so both finishers worked with the floats until the floor was finished at 4:30 p.m. The laborers used on mixing and wheeling were put on other work as soon as their task was completed. Here is a summary of the costs:

Two laborers to mix, 7 a.m. to 2 p.m., 6½ hr. each at 30c. per hr =	$3.90
One laborer to wheel finish onto floor, 6½ hr. at 30c. per hr =	1.95
One laborer to broom and use big float, 8½ hr. at 30c. per hr =	2.55
Two finishers, 9 hr. each at 60c. per hr =	10.80
Total labor cost	$19.20

Total area = 35 x 95 ft. = 3,325 sq.ft.
Unit cost = $19.20 ÷ 58c. per 100 sq.ft.
3,325

One-half hour was taken for lunch.

Use Freight Car Axle to Repair Broken Steam Shovel

By JAMES W. OWENS
Erie, Pa.

WE BROKE the front axle on our 85-ton steam shovel. In the ordinary run of things it would have taken from one to two weeks to get a new axle from the factory.

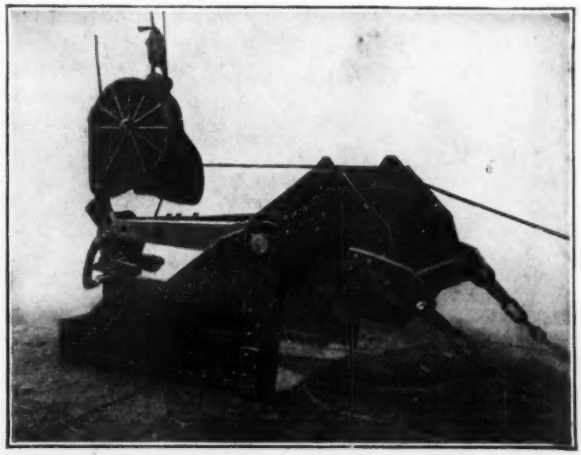
There was a gondola car on our sidetrack so we took a set of wheels from one of its trucks to substitute on the shovel. Finding the axle too small for the propelling gear, we had a bushing made from sheet steel to fit the axle and gear. We keyed this to the axle. By working all night on the job we managed to carry on the steam shovel work with only a few hours' delay.

A new axle for the steam shovel was ordered by wire. When it arrived, we removed the borrowed wheels, had a piece of steel cut to fit the keyway cut in the axle, and welded it in place with an acetylene torch.

Drag-Line Bucket Loads Within Its Own Length

EXCAVATING buckets of a new type which may be termed drag-line buckets were used with drag-line excavators on the Hudson River improvement work at Waterford, N. Y. Side plates extending above the front or cutting end of the bucket form bearings for a cross shaft which carries an end gate and a hoisting arm. The chain bail for the drag line is attached to the end gate, and the block of the hoist line is attached to the arm, which has a hooked latch to engage a bar across the rear of the bucket. A dump line hitched to this bar passes over a sheave outside of the hoisting block and leads forward over the bucket, in front of which it is attached to the drag line.

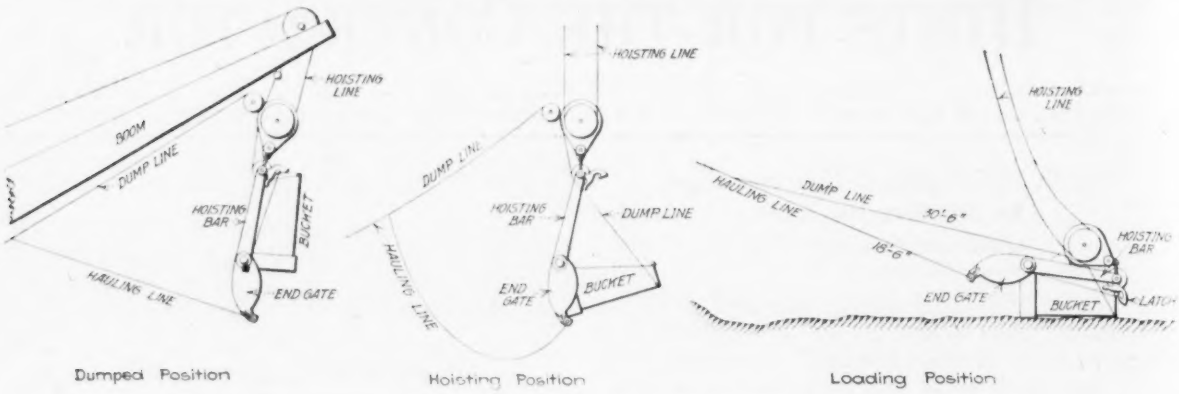
In making its cut, the bucket is in the position shown in the view. When loaded, the hoisting line is hauled



THIS DRAG-LINE BUCKET HAS A PIVOTED END GATE

in, raising the arm to a vertical position and lowering the end gate, the bucket then being suspended in a horizontal position with the bar at one end and the dump line at the other. For dumping, this latter line is hauled in, so that the bucket revolves around the cross shaft and thus swings clear of the end gate.

The bucket will take a load in traveling its own length, and then can be hoisted at once instead of being pulled to the bank of the drag line. The end gate holds the load, but at the same time allows water to escape. Experience showed that the cables lasted longer and



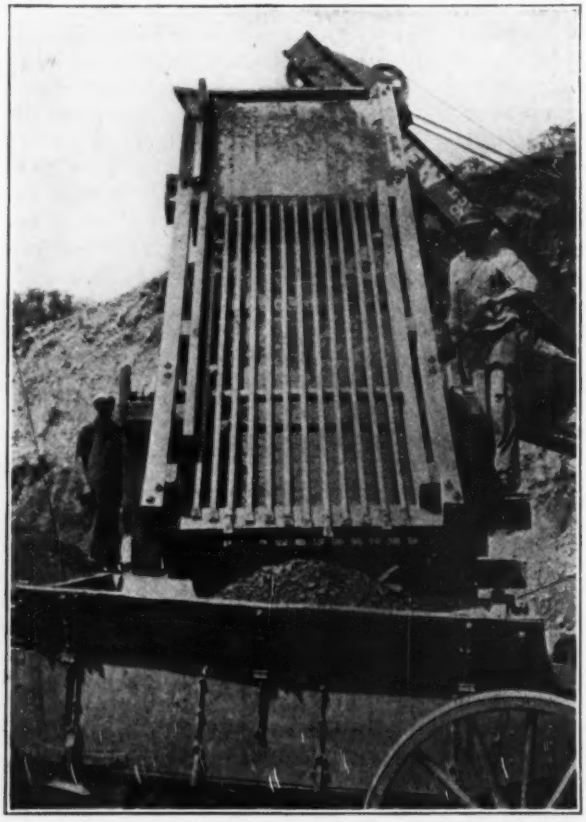
POSITIONS OF BUCKET AND LINES

the machine consumed less coal than when an ordinary bucket was used.

These buckets were designed by H. T. Dunbar, president of the Dunbar & Sullivan Dredging Co., Buffalo, N. Y. They were made at the company's machine shops on the work at Waterford N. Y. They are of 3-yd. capacity.

Steam Shovel Dumps a Tilting Gravel Screen

TO AVOID rehandling gravel, either before or after screening, Fred Ellis, of Malden, Mass., devised the screener illustrated, for use on a state road contract near Albany, N. Y



SHOVEL DIPPER LIFTS SCREEN TO LOAD WAGON

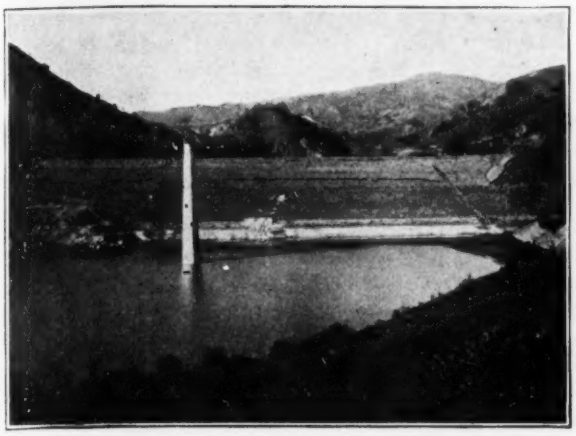
A steam shovel dug the gravel from a large bank. It was necessary to screen the gravel before use. The shovel boom was not of sufficient length to place the gravel high enough so that after screening it would fall, without another handling, into the wagons or motor trucks. The tipping screen, devised to overcome this, consisted of a screen frame about 10 ft. long and 6 ft. wide. The screen proper was of wire netting with 1-in. by 6-in. openings. On top of this was a coarser screen composed of iron pipe placed 3 or 4 in. apart. These were to protect the wire screen from the heavier pieces of gravel and were placed about 6 or 8 in. above the wire.

The screen was supported at one end on a timber frame, to the lower end of which was fastened a chain. The other end was supported on a somewhat larger frame by means of a piece of iron pipe acting as a hinge or bearing. After the shovel had dumped gravel on the screen, the bucket was lowered, a tooth caught in the chain and the whole end of the screen carried, revolving about the pipe bearing, so that the material retained on the screen slid off into the wagon or truck waiting to receive it.

The whole outfit was cheap and easy to make. It was also easily portable and speeded up the work.

High-Magnesia Cement Tests

Technological paper No. 102, recently issued by the Bureau of Standards, gives the result of researches into the effect of high magnesia contents upon the physical properties of the resulting portland cement. A series of cement was burned in the bureau's experimental rotary kilns, varying percentages of the limestone used in the raw material being replaced by dolomite. A magnesia content as high as 25% was obtained in the resulting cement and the clinker was examined petrographically. The constituents present, their amount, and the character of their formation were carefully studied. The clinker was also ground and the resulting cement subjected to the usual test for physical properties, showing that cement containing not to exceed 8% magnesia will produce concrete of satisfactory strength at the end of 1½ years—although these cements seem to hydrate with a large increase in volume. The publication, entitled "The Properties of Portland Cement Having a High Magnesia Content," is a part of the program of the investigation.



Middle Section of Upstream Side of Calaveras Dam Slips Into Reservoir

Part of Clay Core Also Goes, and 230-Foot Outlet Tower Topples—Estimated That Slide Involes 800,000 of 2,800,000 Yards Placed to Date—First Problem Now to Open Buried Outlet Culvert

By Allen Hazen and Leonard Metcalf

On Sunday morning, Mar. 24, at 7:30, the central section of the upper part of the upstream side of the Calaveras dam, near San Francisco, and a large part of the clay core material slid out into the reservoir. As the break came early in the morning there were few at the dam, and fortunately no one was injured. No damage is done beyond the financial loss involved in the necessary repairs which will be undertaken by the company at once.

Calaveras dam is to be 210 ft. high above the stream bed and 240 ft. above bedrock; the highwater line will be 20 ft. below the top, so that the greatest depth of water back of the dam will be 190 ft. Construction had reached a point only 40 ft. below the top, and 20 ft. below the flow line. The final top will be at El. 800.

The Calaveras dam is being built by the Spring Valley Water Co. for the purpose of supplying San Francisco with water. It has been under construction for some four years. It is a hydraulic-fill dam, but dry rock fill has been freely used on both of the toes, and the material so placed forms nearly half of the total yardage to date. The length on the top is to be 1300 ft. with a total width of 25 ft., at a level 20 ft. above the spillway crest. The slopes are normally 3 to 1 upstream, and 2½ to 1 downstream, but with several berms, and the total thickness at the bottom is about 1300 ft.

Early descriptions of the construction with detail drawings showing the design may be found in *Engineering News*, Oct. 1, 1914, p. 692, and *Engineering Record*, Aug. 19, 1916, p. 220.

In the course of the construction of the dam trouble had been experienced with the character of the available sluicing material, on account of its excess of fine particles. This had led to a modification of the original plans by the placing of a large amount of material by steam shovels, wagons and cars upon the outside of the upstream and downstream embankments.

No movement of the downstream embankment has ever been noticed, and there has been no apparent evidence of bulging or mammaling of the upstream slope, such as was observed in the Necaxa dam before its failure. The first movement in the upstream embankment was noticed June 18, 1917. This movement caused the gate stem, lying upon the surface of the upstream slope and controlling the outlet-culvert sluice gates, to bulge and to slide one of the 4 x 6-ft. sluice gates 4 in. beyond the edge of its seat. Three lines and levels across the dam were immediately established, and later a fourth one—the first, between El. 729 and El. 731; the second, El. 700 and El. 708; the third, El. 672 and El. 678; and the fourth at El. 641. The top edge of the concrete paving from which stone paving ran to the top of the dam was at El. 663.

While the amount of the initial movement prior to the beginning of measurements on June 18, 1917, is, of course, unknown, it has been estimated, from the distortion of one of the gage boards on the upstream face of the dam, to have been about 18 in. horizontally, and during 12 hours following the first observation a further horizontal movement of 6 in. was observed on the upper concrete gate-stem block operating at El. 708.7. The concrete slope, 4 in. or more in thickness, lifted and cracked, parallel to the upper edge and 6 ft. below it, for a distance of 700 ft. more or less, across the dam.

At the top of the upstream embankment of the dam it was noticed that there were cracks at an angle of about 45° with the crest line, converging toward the reservoir. On the easterly end of the dam these cracks were about 25 ft. distant from its contact with the hillside and on the westerly end about 200 ft. from the westerly hillside.

Sluicing was immediately stopped—on June 18, 1917. The horizontal movement continued at a decreasing rate until June 21, when it practically ceased.

Sluicing was resumed July 7, 1917, and continued for 12 days, when movement was again observed and sluicing was discontinued. Steam-shovel work was continued, however, the upstream embankment being widened out 60 ft. into the pool and raised 32 ft. from El. 740 to El. 772, and the downstream embankment being raised to El. 763 and widened 60 ft. toward the center of the dam. Although no more sluicing was done, the pool level gradually rose about 12 ft., as a result of the sinking of the solid fill into it.

On Feb. 12, 1918, sluicing was resumed, the water level in the reservoir being at El. 641.6. The hydraulicked clay core, about 75 ft. in width, was at El. 752, approximately 110 ft. above the reservoir water level. The upstream embankment, 84 ft. in width at its top, was then at El. 765; the downstream embankment, 60 ft. in width at its top, at El. 763; the outside upstream embankment slope being 3 to 1, the downstream embankment approximately 2½ to 1.

LOOKING UPSTREAM FROM TOP OF STANDING PART OF DAM—IN FOREGROUND FLOWING CLAY RUNNING OUT AT LEFT TO RESERVOIR—OVERTURNED UPSTREAM SECTION IN MIDDLE DISTANCE

Shortly thereafter a slight outward horizontal movement of the upstream embankment was again observed and continued to increase until Mar. 4, when sluicing was again stopped. On the day before the failure of the dam, the observed horizontal movement was 2.39 ft. at one point, to which amount must be added the initial movement, roughly estimated at 18 in., giving an approximate total maximum horizontal movement of 4 ft., from June 18, 1917, to Mar 24, 1918.

The final movement at the time of failure on Mar. 24, 1918, was very rapid. The greater part of it probably took place within a space of not more than five minutes. The reinforced-concrete outlet tower was thrown forward into the reservoir. The noise and splash and waves of this drew the attention of those who were nearby to what was going on. Alice Espy, the nine-year-old daughter of the constructing engineer, saw the tower fall. Her attention was drawn to it by the noise, which some of the men also noticed. Looking toward the dam she saw the tower, 230 ft. high, swaying back and forth for a moment, after which it fell in a direction straight away from the dam. It has not been seen since.

It seems likely that the first considerable movement was a drop in the level of the central pool on the top of the dam, accompanied by a slow lifting, or moving forward, of the surface of the upstream toe above the water line. The lower part of the toe had been paved with concrete, and this extended about 13 ft. above the water level. Above that point the face was covered with a heavy, stone riprap. The top of the concrete formed a conspicuous line, and observers say this seemed to rise several feet. This may have represented an actual rise, or it may simply have been a lifting at the edge by the forward movement of the mass. There was then a forward movement of the whole central section. The section that moved was about 700 ft. long.

The first break was probably near the east, or right-hand side, vertically along the line of some timber work which had served during construction to return the excess water from the central pool to the reservoir above the dam. It may have been the breaking of these timbers that made the noises that were first heard. The dam started to move forward toward the reservoir. The dam moved more rapidly on the east end and so revolved as it moved. When it stopped it had turned something like 30° from its original direction. The movement was something like the opening of a door.

Before the moving part had gone very far the material in the clay core began to come through the opening, and the central part of the dam emptied itself to a considerable extent through this breach. As the surface level fell, the material appeared to drain from the valley slopes in the interior of the dam toward its center, and thence out of the eroded channel, on the east, into the reservoir.

The total depth of the hydraulic fill in the center was about 155 ft. The material had been tested regularly to find how it was solidifying. The first method used for determining this was to ascertain the depth to which a man could force a 1¼-in. pipe down into the material from a boat. On Mar. 16, 1916, and at intervals thereafter until Jan. 24, 1917, the material was found to be so plastic that the pipe could be forced to a depth vary-

ing from 75 to 90 ft. On Feb. 12, 1917, the method of determining solidification by the use of a pipe was given up for the more certain procedure of lowering a 6-in. cast-iron ball into the core material and measuring

LOOKING DOWN ON DOWNSTREAM SECTION IN PLACE—DISPLACED UPSTREAM SECTION IN BACKGROUND

the depth at which its movement ceased. This was found to be about 45 ft., or approximately one-half the depth to which it had been possible to force a pipe.

A few days before the latter date sluicing had been discontinued, and was not again resumed until Feb. 12, 1918. The effect of this rest upon the core material is interesting, for upon the next observation, Aug. 27, 1917, the depth of penetration of the cast-iron ball was but 12 ft., as compared with the measurement of 35 ft. a month prior. On Oct. 24, 1917, the penetration was but 8 ft., and on Jan. 21, 1918, but 5 ft.

Notwithstanding the solidification indicated by these tests, when the material was released it started to flow almost like water. At first it came through the narrow breach as a turbid cataract with a steep slope, but the opening rapidly widened and the slope flattened until the center was drained down to within a few feet of the water level in the reservoir. Probably within five minutes the rapid movement was over, although the clay continued to flow at a reducing rate for some time. The more solid material of the upstream part of the dam, consisting largely of heavy rock fill, had then moved forward and downward and had filled a space for several hundred feet beyond where the toe had been. This material must be piled up to a height in places of 70 ft., and it stands high above the water and far out into the reservoir.

Soundings taken in the reservoir in front of the visible material indicate that there is a well defined trough parallel to it, and at a distance of 60 ft., more or less. Beyond it is a well marked ridge from which the material slopes gently to the bottom of the lake. Rock and gravel lie on top of the greater part of the material under water, the clay of the core being found, for the most part, at the easterly end of the dam, and at the foot of the slope outside of the coarser material.

It is estimated roughly that 800,000 cu.yd. of material must have moved in the slide. As about 2,800,000 cu.yd. had been placed in the dam, the movement affects rather less than one-third of the whole. The remaining material, 2,000,000 cu.yd., more or less, remains in position. This includes practically the whole of the lower, or downstream part of the dam. This did not move, although there is some sloughing off of the steep exposed face, and there has been a little settlement, indicated by cracks on and near the top, due to the release of the load of the central pool upon it.

When the outlet tower was carried off its base by the sliding mass, the end of the outlet tunnel must have been left open for a movement, but it was at once covered and sealed by the moving mass, and no appreciable amount of water escaped through the tunnel. There is now about 70 ft. of material over it.

To open this outlet, or otherwise to dispose of the water now in the reservoir, will be the first, and perhaps the most difficult, work of rehabilitation. Present indications are that entrance can be made from the reservoir to the outlet culvert through a rock tunnel some 500 ft. long.

In this connection, and as bearing upon the hazards of the present situation, it is interesting to note that the downstream embankment of earth and stone placed almost wholly by steam shovel and which supported the clay core, stands at an elevation of about 745 ft., which is 145 ft. or more above the floor of the valley, and nearly 95 ft. above the present water level in the reservoir. The normal seasonal run-off of the Calaveras basin occurring after Apr. 1 would raise the present water level by 17 ft. only, and the maximum recorded run-off by 37 ft. The available storage to the top of the structure, at the approximate level of the roadway across it at about elevation 745 ft., affords a margin in

STANDING UPSTREAM SECTION AT LEFT—SECTION OF DOWNSTREAM SECTION AT RIGHT BACKGROUND
Note clay stream flowing through middle of view.

depth of storage approximately 20 ft. in excess of the recorded mean annual run-off of the Calaveras basin, so that there is ample time within which to make connection with the outlet culvert before the next rainy season.

George A. Elliott is engineer of the Spring Valley Water Co. F. C. Herrmann was engineer of the company when the plan was adopted and the work started, and during the early part of the construction. William Mulholland, of Los Angeles, has been consulting engineer for this work since its inception. T. W. Espy is resident engineer, and has been in charge of the work since the beginning.

NEWS OF THE WEEK

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Director General Restricts Railroad Expenditures

The director general of railroads has issued the following regulations governing expenditures for capital account:

1. Expenditure for additions and betterments, including equipment, are to be limited by consideration of the necessity for such expenditures, as in relation to conserving the available supply of labor and materials. Certain projects which might be considered necessary under private control may not be equally meritorious during the period of control by the Government, it is pointed out, since all facilities are now available for common or joint use.

2. Construction of new lines and branches are not to be entered upon without the approval of the director general.

3. New cars and locomotives shall not be ordered without the approval of the director general.

4. Work contracted for or commenced prior to Jan. 1 may be continued except as the judgment of the individual carrier indicates the possibility of discontinuing such work in order to conform to the general principles of paragraph 1.

5. Other work involving charges to capital of less than $25,000 may be undertaken without approval of the director general, provided that such work with the general principles of paragraph 1; that it falls within the policy of the individual carrier for the years 1916 and 1917, and that reports shall be rendered in duplicate to the director of the Division of Capital Expenditures at Washington and the regional director for the district, indicating each capital expenditure of $5000 to $25,000, and amounts chargeable to operating expenses.

6. No single work involving a capital expenditure of more than $25,000 shall be undertaken unless it conforms to the principles in paragraph 1 and unless it has the approval of the director general.

Strike on New York Subway Work

Another strike began to develop on the subway work in New York City on Monday morning when the carpenters, form builders and laborers walked out on one section in Manhattan and several in Brooklyn. The demands are said to involve an increase in wages.

The previous subway strike was settled by an agreement that the increases then granted would be the last until the new subway system was finished.

It was feared that the strike would become general.

War Labor Board Recognizes Right to Organize

Report Provides Plan for Adjusting Disputes and Makes Recommendation for Maintaining Maximum Production

The War Labor Conference Board has made a report to the Secretary of Labor, at whose suggestion it was appointed to aid in the promotion of a national labor program for the period of the war. The report embodies recommendation for maintaining maximum production, recognition of the basic eight-hour day, as well as detailed recommendations for creating a national war labor board, to be selected in the same manner as the present board, and in which employers and workers will be equally represented.

The report provides that the functions and powers of the national board shall be to bring about settlement of labor controversies by mediation, to exercise the same power in other controversies which result in delayed or decreased production, to appoint local or district boards to act as local mediators and to summon the parties to a controversy for hearing. In the event of the failure of the national board to arrive at a voluntary settlement unanimously, the report provides for the selection of an umpire to be chosen by unanimous vote of the national board or, failing this, to be drawn by lot from a list of ten disinterested persons nominated by the President of the United States. When an existing agreement or a Federal law has not been invoked as a means of settling a controversy the board may refuse to take cognizance of the controversy.

It is further provided that the action of the national board may be invoked, with respect to labor controversies, by the Secretary of Labor or by either side of a controversy, but the national board may subsequently refuse to take cognizance of the case if its importance does not justify it.

It is specifically provided in the report that the board, in its mediating and conciliatory action, and the umpire in his consideration of a controversy, shall be governed by the following principles:

Right to Organize

1. The right of workers to organize in trade unions and to bargain collectively, through chosen representatives, is recognized and affirmed. This right shall not be denied, abridged or interfered with by the employers in any manner whatsoever.

2. The right of employers to organize in associations or groups and to bargain collectively, through chosen representatives, is recognized and affirmed. This right shall not be denied, abridged or interfered with by the workers in any manner whatsoever.

3. Employers should not discharge workers for membership in trade unions, nor for legitimate trade union activities.

4. The workers, in the exercise of their right to organize, shall not use coercive measures of any kind to induce persons to join their organizations, nor to induce employers to bargain or deal therewith.

Existing Conditions

1. In establishments where the union shop exists the same shall continue and the union standards as to wages, hours of labor and other conditions of employment shall be maintained.

2. In establishments where union and non-union men and women now work together, and the employer meets only with employees or representatives engaged in said establishments, the continuance of such condition shall not be deemed a grievance. This declaration, however, is not intended in any manner to deny the right or discourage the practice of the formation of labor unions, or the joining of the same by the workers in said establishments, as guaranteed in the last paragraph, nor to prevent the War Labor Board from urging, or any umpire from granting, under the machinery herein provided, improvement of their situation in the matter of wages, hours of labor, or other conditions, as shall be found desirable from time to time.

3. Established safeguards and regulations for the protection of the health and safety of workers shall not be relaxed.

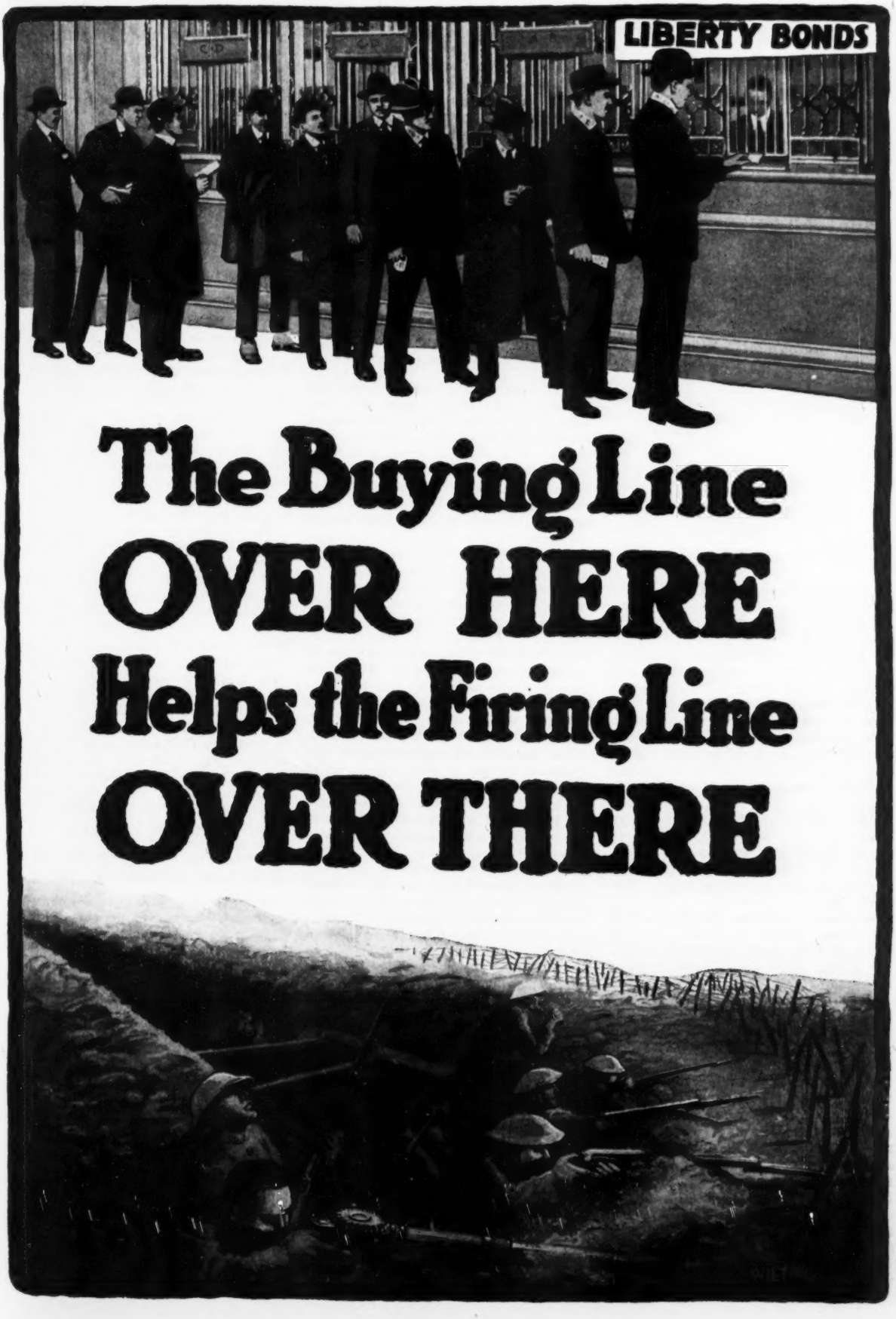
Women in Industry

If it shall become necessary to employ women on work ordinarily performed by men, they must be allowed equal pay for equal work and must not be allotted tasks disproportionate to their strength.

Hours of Labor and Maximum Production

The basic eight hour day is recognized as applying in all cases in which existing law requires it. In all other cases the question of hours of labor shall be settled with due regard to governmental necessities and the welfare, health and proper comfort of the workers.

(Concluded on page 685)


LIBERTY BONDS
The Buying Line
OVER HERE
Helps the Firing Line
OVER THERE

Chicago Completes 8-Mile Tunnel Under Lake and Land

Completion of the 12-ft. Wilson Ave. intake tunnel at Chicago marks an important step in the increase of water-supply for that city. The tunnel extends in solid rock three miles under Lake Michigan to an intake shaft and crib, and five miles under the city to a new pumping station. It is of horse-shoe section, 13 x 13 ft. for one mile from the intake shaft, and 12 x 12 ft. for the remaining seven miles. Records of progress are given in the following table:

PROGRESS OF WILSON AVENUE WATER TUNNEL, CHICAGO

	Lake Tunnel	Land Tunnel
Length	3 miles	5 miles
Section	13 x 13 ft. (1 mile) 12 x 12 ft. (2 miles)	12 x 12 ft.
Work started	Drift No. 2 Feb., 1914	Drift No. 3 Feb., 1914
Dates of holing through:		
Drifts 1 and 2	Sept., 1917	
Drifts 7 and 8		Dec., 1915
Drifts 3 and 4		Sept., 1916
Drifts 5 and 6		July, 1917
Lining finished	Feb., 1918	Feb., 1918
No. of shafts	2	3
Max. length of drift	No. 2: 14,850 ft.	No. 6: 7,500 ft.
Max. monthly progress:		
Tunneling	564 ft.	630 ft.
Lining	2,076 ft.	2,175 ft.
Normal monthly progress:		
Tunneling	500 ft.	540 ft.
Lining	1,178 ft.	1,200 ft.

Special features of this 8-mile tunnel were the exceptional length of drift for the lake tunnel, 14,850 ft., and the direct transfer of excavated rock from the heading to screening and pneumatic concreting plants traveling on a narrow-gage track in the tunnel. Another notable feature is that the work was done by day labor under the Department of Public Works, except that a contract was let for the intake shaft and crib, as the city had not the special equipment required for this work in deep water.

Saving of about 20% in time of construction is thought to have been effected by the introduction of the novel method of delivering the tunnel rock directly to the concreting plant. The 3-mile lake tunnel was driven from the shore shaft, with an average haul of 1½ miles. The rock required for the lining of this tunnel amounted to 47,520 cu.yd. This would have required 1900 trains for transportation, which at the rate of 5 miles per hour would have taken 1140 hours of work. The hoisting of these 47,520 cars of rock and the lowering of the aggregate would have required about nine months of working time. Adding to this the time saved by reduction of traffic and switching, it is estimated that a total saving of one year may be credited to this new method of working. The construction of the tunnel occupied just four years, from February, 1914, to February, 1918. It may be assumed, therefore, that under ordinary methods the time would have been increased to five years.

Day-labor construction of the tunnel was adopted on the recommendation of John E. Ericson, city engineer, and the work has been carried out under his direction. It was in direct charge of Henry W. Clausen, engineer of waterworks construction. Visits of inspection to the finished tunnel, by means of the narrow-gage construction tracks, were made Mar. 22 by city officials and Mar. 23 by members of the Western Society of Engineers. Description of this great tunnel, with the construction methods and plant employed, will be found in *Engineering News-Record* of July 26 and Oct. 4, 1917; *Engineering Record* of Jan. 16 and 23, 1915; May 25, 1916; *Engineering News* of Apr. 22, 1915 and May 25, 1916.

Canadian Engineers Discuss Fuel and Power Situation

Fuel and power problems in the Dominion of Canada were the sole topic of discussion at the first general professional meeting of the Canadian Society of Civil Engineers, held Mar. 26-27 in Toronto. There was an attendance of about 150 members. Great stress was laid by the speakers upon the need of developing Canada's fuel resources.

The opening address was delivered by Sir William Hearst, Premier of Ontario, who reviewed the action taken by the Provincial government to relieve the fuel shortage and promote the development of the peat industry. B. F. Haanel, chief of the fuel division of the Canadian Department of Mines, delivered a comprehensive address embodying estimates of the peat and coal resources and dealing with processes for preparing peat and dignite for fuel.

The question of transportation was discussed by W. N. Neil, secretary of the Canadian Railway Association, who set forth the difficulties the railways had to contend with in connection with fuel shortage and the great economies already effected. W. J. Dick, mining engineer of the Commission of Conservation, urged that the area served from the coal fields of western Canada could be considerably enlarged by special railway rates, and suggested a pooling of interests by the mines to secure more economic development. John Blizard of the Division of Fuels of the Mines Department described the process of producing a commercial fuel from peat. E. Stansfield of the mines branch dealt with the briquetting of bituminous coals.

The addresses delivered on the second day dealt principally with the development of water powers to provide hydro-electric power as a substitute for coal. Among those who treated of this phase of the question were J. B. Challies, of the Department of the Interior; J. M. Murphy, chief electrical engineer of the Department of Railways, and P. H. Mitchell, Toronto. Albert Grigg, Deputy Minister of Lands and Forests for Ontario, spoke of what the province was doing to supply wood fuel.

Draftsmen Wanted in Ordnance Department of Army

The Ordnance Department of the U. S. Army wishes to obtain 200 draftsmen for work from May 1 to Oct. 1 at salaries up to $100 per month. The minimum requirement for these positions is two years of college training in mechanical drafting or machine design. More highly skilled men are needed for positions paying up to $3000 per annum. For further particulars address Maj. E. M. Bainter, Instruction Section, Ordnance Department, 1330 F St., N.W., Washington, D. C.

In some of these services it is probable that particularly well-qualified men may be desired for the period of the war, receiving military status and assignment to special war work.

Pursell Rescued, Kyle Still Held by Chinese Bandits

E. J. Pursell, one of the American engineers captured by bandits in northern Honan Province early last month and held for ransom, has been rescued by soldiers, who intercepted the band as they were attempting to retreat further into the mountains.

The bandits succeeded in carrying off their other captive, George A. Kyle of Portland, Ore., who is reported in good health and being fairly well treated. Efforts are being made by the state department to effect the release of Mr. Kyle, and the department and the Seims-Carey Ry. & Canal Co., with which he is connected, are keeping in close touch with the situation.

Mr. Pursell is general superintendent and Mr. Kyle is chief engineer of the Siems-Carey Co.'s railway projects in northern China. A long biography of Mr. Kyle, giving details of his career as a railway engineer and as a mining engineer in South Africa, and containing his portrait, was printed in *Engineering Record* of Oct. 21, 1916.

Government Is Appraising Hoboken Steamship Piers

A board of appraisal of the War Department is now engaged in making a physical examination, appraisal and estimate a cost of all of the property of the North German Lloyd and Hamburg American Steamship Companies in Hoboken, N. J. This appraisal will consist in a valuation of all piers, bulkheads, warehouses, buildings, appurtenances, machinery, etc., making up this whole terminal installation. Charles W. Staniford, Chief Engineer of the Department of Docks and Ferries of New York City has been put in charge of the work.

Water-Works Tunnel Planned

A 9-ft. concrete-lined tunnel 7000 ft. long is being planned for the City of Milwaukee. It will extend from the shore shaft of the new intake tunnel across the city to the proposed west side pumping station at Chambers St., on the west side of the Milwaukee River.

Labor Right to Organize

(Concluded from page 682)

The maximum production of all war industries should be maintained and methods of work and operation on the part of employers or workers which operate to delay or limit production, or which have a tendency to artificially increase the cost thereof, should be discouraged.

MOBILIZATION OF LABOR

For the purpose of mobilizing the labor supply with a view to its rapid and effective distribution, a permanent list of the number of skilled and other workers available in different parts of the nation shall be kept on file by the Department of Labor, the information to be constantly furnished:

1. By the trade unions.
2. By state employment bureaus and Federal agencies of like character.
3. By the managers and operators of industrial establishments throughout the country.

These agencies should be given opportunity to aid in the distribution of labor as necessity demands.

In fixing wages, hours and conditions of labor regard should always be had to the labor standards, wage scales, and other conditions prevailing in the localities affected.

THE LIVING WAGE

1. The right of all workers, including common laborers, to a living wage is hereby declared.

2. In fixing wages, minimum rates of pay shall be established which will insure the subsistence of the worker and his family in health and reasonable comfort.

The members of the board subscribing to the report are:

B. L. Worden	Wm. L. Hutcheson
Wm. H. Taft	Frank J. Hayes
C. E. Michael	Frank P. Walsh
L. F. Loree	T. A. Rickert
W. H. VanDervoort	Victor A. Olander
Loyall A. Osborne	Thomas J. Savage

Agree on Water-Power Legislation

The prospects for favorable action by Congress on water power legislation are said to be notably improved by the agreement reached by the special joint water-power committee, which has been conducting hearings for the past three weeks on the socalled "administration" bill, to add the main features of this bill to the Shields water-power bill which passed the Senate Dec. 14 and is now pending in the House. In this form the bill can go at once to conference, and the conference committee will be made up of Judge Sims, chairman of the House special water-power committee, and Senator Shields.

It is authoritatively stated in Washington that Senator Shields has made up his mind to accept a number of the most important provisions of the "administration" bill when they are tacked on to his bill as amendments, and there is reported to be a disposition among senators to advance the measure.

Water-Works Chemicals Difficult To Get

Priority for Needed Supplies Asked by Indiana Sanitary and Water-works Association

Priority for chemicals used in water-works purification plants was asked in the main resolution passed by the convention of the Indiana Sanitary and Water-Supply Association which met in Indianapolis Mar. 27-28. Other topics that elicited spirited discussion were the protection of meters from frost, war time public utility sacrifices, and sewage disposal for Indianapolis.

George W. Fuller, consulting engineer for the Indianapolis Board of Sanitary Commissioners, disposed of this last subject in a paper in which he outlined the report he made recently recommending screens, deep sprinkling filters and sludge recovery basins. As in the report, Mr. Fuller explained that the occasional odors which were almost sure to be given off from Imhoff tanks would defeat the very object for which the plant would be constructed. The report was abstracted in *Engineering News-Record* of Nov. 22, 1917, p. 972.

Difficulties which many filtration plants have encountered in getting alum and chlorine led to resolutions asking that the authorities give these articles a priority rating. Time and again chlorine has had to be shipped by express from Niagara Falls to Indianapolis, and the Terre Haute plant found it necessary to get alum the same way from Joliet, Ill. The chemical company at the latter point has found it extremely difficult at times to get cars in which to load bauxite at its southern mine. To remedy part of the difficulty the Electro Bleaching Co. has established a distributing warehouse at Joliet, Ill., for it can get carload shipments on a single priority order and avoid delay by sending a man with the car. Plants using these chemicals are urged to set forth their requirements to the proper authorities in their respective states. W. S. Cramer, Lexington, Ky., informed the members the situation had become so acute that the American Water-Works Assn. would soon have a representative in Washington to look after this and other problems confronting water-works officials.

The freezing of an unusual number of meters was reported this year, but Dow R. Gwinn, president of the Terre Haute Water Co., and leader of the round table discussion on this subject, said he was not able to say how to set a meter to prevent freezing. Practically every kind of setting his company used had its quota damaged. The discussion finally brought out this solution: Set the meter in a tight box at any elevation, but be sure that the bottom of the box or pipe is well below frost line, so that the warm earth may act as a radiator. A simple expedient is to sink a hole below the bottom of the box with a post-hole auger and to drop in two or three lengths of tile pipe.

The question of the regulation of plumbers is the bane of the lives of water-works officials, in many cases. This problem appeared to be minimized greatly in towns fully metered, where poor work resulted in the consumer paying the increased bills due to defective plumbing. Where the flat rate system is in vogue strict licensing was recommended.

A novel feature of the program was a meeting held in the unusually clean boiler room of the Indianapolis Water Co., at which the principal technical paper was on "Design and Operation of Boilers for Water-Works Service," by George W. Bach, member of the War Service Commission, who demonstrated good practice by the examples before him. Too little attention is given to boiler room economies — mainly because of the inconvenience encountered in making boiler tests. Frequently more economies can be effected here than elsewhere.

W. H. Durbin led a round table discussion on "Practical Operation of Small Filter Plants." That records should be kept and washing of rapid filters should take place at least every two days were points made. H. E. Jordan said analyses should be made frequently as the man in charge should know more about his product than others.

Dr. W. F. King was reëlected president of the association, and W. G. Ulrich, Indianapolis, secretary and treasurer. J. A. Craven is to be Mr. Ulrich's assistant.

American Society Again Dispenses with Annual Convention

The American Society of Civil Engineers has again abandoned its annual convention. Reasons given are the absence of many members in the service of the country, the inappropriateness of social functions at this time, the limitation of transportation facilities and the advisability of economy along all lines.

How Engineers Are Helping To Win the War

The metropolitan and student branches of the New York Section of the American Society of Mechanical Engineers will hold Apr. 8 a joint afternoon and evening meeting, which will be devoted largely to addresses for developing the salient features of how engineers are helping to win the war. The speakers will be M. H. Avram, president Slocum Avram Slocum Co.; Charles Whiting Baker, consulting editor *Engineering News-Record;* F. R. Low, editor *Power;* C. T. Main, president American Society of Mechanical Engineers; C. R. Mann, director Carnegie Foundation; G. A. Orrok, consulting engineer; Dr. Ira N. Hollis, president Worcester Polytechnic Institute; R. B. Sheridan, vice president American International Corporation, and B. F. Hall, Jr., U. S. N. R. F.

F. E. Lamphere Also a Colonel

Through a typographical error the note in last week's issue telling of the promotion of a number of officers in the new Construction Division of the army failed to state that Frank E. Lamphere, the constructing quartermaster at Fort Newark had been made a Colonel, Q. M. C., National Army. Col. Lamphere has had long experience in railway construction, being at the beginning of the war with the Baltimore & Ohio R. R. at Chicago. He was constructing quartermaster at Camp Zachary Taylor, Louisville, Ky., and is now in charge of the large port terminal work near Newark, N. J. He and Col. Butler, now at Norfolk, Va., were the only two field construction men to be made colonels in the recent promotions.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN WATER-WORKS ASSOCIATION; 47 State St., Troy, N. Y.; May 13-18, St. Louis, Mo.

AMERICAN ASSOCIATION OF ENGINEERS; 29 South La Salle St., Chicago; May 14, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS; 29 West 39th St., New York; Spring meeting, June 4-7, Worcester, Mass.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS; 129 York St., Brooklyn, N. Y.; June 19-22, Berlin, N. H.

AMERICAN CONCRETE INSTITUTE; 27 School St., Boston; June 24-26, Atlantic City, N. J.

AMERICAN SOCIETY FOR TESTING MATERIALS; University of Pennsylvania, Philadelphia; June 25-28, Atlantic City, N. J.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS; 29 West 39th St., New York; Atlantic City, June 26-28.

Road construction was the general topic of discussion at the meeting of the **Engineers and Architects' Club of** Louisville, Ky., Mar. 19. Rodman Wiley, commissioner of roads, discussed "The Road Situation in Kentucky"; W. F. Brooks, United States senior highway engineer, "The Relation of Traffic to the Type of Road"; and State Road Engineer R. C. Heath, "Selection of Type of Road to Build."

The Cornell Society of Civil Engineers, New York, will hold its annual spring meeting Apr. 5, at which Dean John F. Hayford, of the College of Engineering of Northwestern University, will speak on "What American Science Is Doing for Aviation." Dean Hayford is a member of the National Advisory Committee for Aeronautics. Maj. Ezra B. Whitman will speak on "Some Special Features of Army Life."

The Engineers' Club of Brooklyn, N. Y., Mar. 26-28 gave an exhibition, open to the public, of the products of mechanical industries having national and world markets and manufactured in Brooklyn. The club is planning a large exhibition to be given next year in one of the city's National Guard armories.

At a meeting of **the Canadian Society of Civil Engineers** held Mar. 28. Lieut.-Col. R. W. Leonard, spoke on "Nicu Steel," called one of the greatest advances in metallurgy and of vital importance to Canada. The paper was followed by a discussion by prominent metallurgists and specialists. After the technical paper there was an open discussion on the Montreal branch and the law governing the practice of engineering in the Province of Quebec.

The Civil Engineers' Club of Sioux City, Iowa, at a meeting Mar. 21 was addressed by W. J. Bertke, assistant manager of the Sioux City Gas & Electric Co., on "Toluol."

During the past two months the club has assumed the responsibility of conducting a night class of men, in Class 1 of the draft, in a course of military topography. Various members of the club have taken part in the teaching of the classes. The course was one of a number in a so-called "School for Non-Coms," the idea being to give the men some of the information they need in order to qualify as non-commissioned officers.

Before the Cleveland Engineering Society Apr. 9 William H. Finley, chief engineer of the Chicago & Northwestern Ry., will read a paper on "The Civil Engineer."

The Utah Society of Engineers and the **Salt Lake Section of the American Institute of Electrical Engineers** were addressed Mar. 20 by John H. Lewis, state engineer of Oregon, who spoke on "Western Development and Its Relation to National Transportation Policies."

A public meeting of the **Highway Traffic Assn. of the State of New York** will be held at the Automobile Club of America, New York City, Apr. 16. S. M. Williams, president of the Highway Industries Assn., will speak on "Highway Transportation Jeopardized."

PERSONAL NOTES

JOHN W. ALVORD, Chicago, has been selected as consulting engineer to serve with Frederick Law Olmsted, town planner, Boston, and Burt L. Fenner of McKim, Mead & White, architects, New York, the three men to form an advisory board to the Federal Department of Labor in connection with the housing program, which will invcIve an expenditure of more than $60,000,000.

F. H. FRANKLAND, Shortridge Hardesty and L. C. Lashmet, assistant engineers to Waddell & Son, consulting engineers, New York and Kansas City, have become stockholders and directors of the company, which has been incorporated as Waddell & Son, Inc. Under the new organization Mr. Frankland is managing engineer, Mr. Hardesty designing engineer and Mr. Lashmet office engineer. Dr. J. A. L. Waddell is president of the new company, N. Everett Waddell is vice-president and Mr. Lashmet is secretary and treasurer.

H. U. WALLACE, Boulder, Colo., has been appointed major in the Engineer Officers' Reserve Corps. Mr. Wallace is vice-president and general manager of the Western Light and Power Co., Boulder, and was formerly chief engineer of the Illinois Central R.R., with which road he became connected soon after his graduation from a special course in civil engineering at Purdue University. In 1905 he became third vice-president of J. G. White & Co., Inc., New York City, and in 1912 he went to Boulder.

ALBERT W. SWARTZ, who has been in the Snohomish county engineer's office at Everett, Wash., for a number of years, specializing in concrete construction, has resigned and is waiting orders to report to U. S. A. headquarters for service.

HOWARD TAYLOR, for some years chief engineer of the Spanish River Pulp Co., has resigned to become consulting engineer with the Dayton Wright Aeroplane Co., of Dayton, Ohio.

R.W. HEERLEIN has resigned the position of contracting and chief engineer with the Massillon Bridge & Structural Co., and has accepted the position of manager of sales with the National Bridge Works, Long Island City, N. Y.

R. A. MEEKER, former state highway engineer of New Jersey, has opened offices as a consulting engineer in Newark.

W. W. HUFF, consulting engineer, Kansas City, Mo., has been commissioned a captain in the Quartermaster Corps of the National Army and has been assigned to the Construction Division. He has been in private practice for the past six years and has specialized in steel and concrete bridges.

JOHN HOLE, superintendent of construction for the Toronto Harbor Commission, has resigned to enter private practice.

G. H. BURNETT, engineer with Cotton & Co., Vancouver, B. C., contractors, has resigned his position and has given his services to the Canadian Department of Railways and Canals, in connection with the Canadian Northern Ry. arbitration proceedings. Mr Burnett will make an inspection of the tracks, ballastings and trestles of the railway line.

CHARLES BRADFORD, connected with the county engineer's office, Snohomish County, at Everett, Wash., for the past five years, has resigned to accept a position with the Washington Paving Co. of Seattle. He will be superintendent of paving for the company.

HAROLD A. RANDS, consulting engineer, Portland, Ore., has been retained by the port of Portland to make a traffic survey of the Upper Columbia and Snake Rivers.

W. G. THOMPSON became state highway engineer of New Jersey, succeeding R. A. Meeker, Apr. 1. R. E. Reed is now assistant highway engineer.

E. M. WEISMAN, formerly engineer with the Powder, Land and Irrigation Co., Baker, Ore., has been appointed roadmaster for Baker County.

HENRY H. BERG, chief engineer of the water and street lighting department of Orange, N. J., has resigned, effective May 1.

JOHN F. BIRNEY, who for four years was county engineer, Snohomish County, and former president of the Washington State Association of County Engineers, has been appointed chief assistant engineer in charge of Whitman County road work, Colfax, Wash., under J. M. McCaw, county engineer.

R. P. HAYES is now assistant engineer of the Joplin division, Missouri Pacific Railroad.

J. E. A. MOORE, Cleveland, Ohio, announces that he will carry on the engineering practice of Marani & Moore.

A. G. HUSTED, assistant engineer, Department of Public Sanitation, Indianapolis, has been commissioned captain in the Sanitary Corps of the National Army. He was formerly connected with the sewage disposal investigations at Cleveland, Ohio.

R. H. HALLSTED, who has been assistant engineer of the Kansas City Terminal Ry., has been made general roadmaster of the Omaha division of the Missouri Pacific R.R., with headquarters at Falls City, Neb. He succeeds C. O. Congdon.

F. A. SCHNEIDERS has resigned as assistant appraiser of the New York State Tax Commission, and W. H. Rhoads has resigned from the Valuation Department of the Jersey Central Railroad, to join the engineering staff of the Ralph R. Rumery Co., Inc., New York City.

R. N. CLARK, assistant engineer on the Missouri Pacific R.R., is now filling a higher position as assistant engineer in the office of the engineer maintenance of way at Kansas City, Mo. He has succeeded C. A. Hewes, now assistant engineer of the Kansas City Terminal Ry. Mr. Clark's successor with the North Kansas division is E. H. Hawkins, hitherto assistant engineer of the South Kansas division.

WILLIAM W. VARNEY has been appointed acting harbor engineer of Baltimore by Mayor Preston. Mr. Varney was formerly city commissioner of Baltimore.

MAJ. WILLIS B. HAYES, Engineer Reserve Corps, formerly superintendent of construction in the Supervising Architect's office, Washington, D. C., has been appointed constructing quartermaster, Camp Upton, Yaphank, N. Y.

MACK GALBREATH, who has been county engineer of Trigg County, Kentucky, has been appointed division engineer by the State Highway Commissioner. His division includes ten counties.

J. W. BEARDSLEY, who has been appointed consulting engineer to the Ordnance Department at large, was chief engineer of the Porto Rican Irrigation Service from 1910 to 1916, when he resigned, and he has recently been acting as a consulting engineer.

He was formerly employed by the J. G. White Engineering Corporation on investigations of irrigation projects, previous to which he was for seven years engaged in engineering work in the Philippine Islands as chief of the bureau of engineering and later as director of public works. He was graduated from Cornell University in 1891, and after service in Newton, Mass., and Chicago, he accepted a position with the Deep Waterways Commission in 1898. Two years later he entered the Corps of Engineers and in 1902 went to the Philippines. As consulting engineer for the Philippine Commission he investigated irrigation works in Java, Burma, India and Egypt.

M. S. DUTTON has resigned his position as superintendent of filtration at the Bubbly Creek filter plant, Chicago stockyards, to become chemist in charge of the filtration plant at East St. Louis, Ill.

W. G. COMBER has resigned as resident engineer in charge of the dredging division, Panama Canal, to take effect this month, and will return to the United States. The slides are under control and all dredges in the canal are on an 8-hour shift. During the past 12½ years he has handled approximately 179,000,000 tons of dredged material and during the slide period has dredged and transported through the congested waters of the cut 23,000,000 tons per year, in addition to providing for the commercial shipping. Mr. Comber has probably dredged more material, earth and rock, than any other living man.

OBITUARY

CLARENCE BOOTH LAMONT, consulting engineer, organizer and head of the firm of C. B. Lamont, Inc., Seattle, died in that city Mar. 21. Mr. Lamont was born at Van Etten, N. Y., Feb. 23, 1877. He was graduated from Cornell as a mechanical engineer in the class of 1900. In that year he entered the employ of the Union Iron Works of San Francisco, and he became soon after consulting engineer with the White Pass & Yukon Ry., later going to Seattle as port engineer for the Pacific Coast Steamship Co. While serving the company Mr. Lamont worked out many new devices for power transmission on ships. One of them was an invention for absorbing the propeller shock on ships driven by screw propellers, permitting an increase of speed without damaging results to the framework of the vessel. On leaving the company, Mr. Lamont organized the Pacific Engineering Co. of Seattle, which built the Seattle, Spokane & Portland Ry. Co.'s docks in Portland, Oregon, and other large works. Later Mr. Lamont became assistant to the president of the Seattle Construction & Dry Dock Co. In 1915 he resigned this post and formed the firm of C. B. Lamont, Inc., consulting engineers. He was one of the organizers of the Skinner & Eddy Corporation, shipbuilders, Seattle.

FIRST LIEUT. CHARLES MERRITT BROOKS of the Thirty-second Regiment of Engineers, died at Camp Grant Hospital Mar. 21. He was formerly with the U. S. Reclamation Service, assistant engineer for the Atchison, Topeka & Santa Fe Ry. Coast Lines for many years, also superintendent for contractors on much of the heavy double tracking work of the line in Arizona and New Mexico. He resigned his position as city engineer of Flagstaff, Ariz., to enter the Engineer Officers' Training Camp. He was appointed to the Thirty-second Engineers last fall.

CLAYBORN R. WALTON, formerly a civil engineer with the Southern Ry. and also with Lane & Co., railroad contractors, died recently at Salisbury, N. C.

FIRST LIEUTENANT JOHN G. KELLY, Company A, Tenth Engineers, was killed in an automobile accident in France Mar. 15. He was born in Grants Pass, Ore., thirty years ago and was a son of Major George H. Kelly, Twentieth Engineers, a forestry regiment, also serving in France. Lieut. Kelly studied civil engineering at the University of Oregon, Massachusetts Institute of Technology and Oregon Agricultural College. He left Portland last June and was for some time stationed at Fort Riley, Kan., later being transferred to Washington, for training at Camp American University.

NEWS OF ENGINEERING INDUSTRIES

FOR MANUFACTURERS WHO SERVE ENGINEERS AND CONTRACTORS

Water Supply of Many Cities in Danger From Chlorine Shortage

Railroads Refuse to Return Empty Tanks Under Present Priority Orders, and Makers Have No Way to Supply Purification Plants—Public Health Threatened

Water-works throughout the United States which are dependent upon liquid chlorine as a sterilizing agent are having great difficulty in securing supplies of this material. This shortage is taking serious aspect. Grave fears are expressed by water-works officials and sanitary experts for the safety of public health in many cities affected by the existing embargo. As most of these cities are large industrial centers and as an epidemic of typhoid fever may be the result of a complete shutdown in the supply of liquid chlorine, the relation to war production of the need for liquid chlorine is apparent.

A general order by the Director General of Railroads, made Feb. 1, this year, has given some relief in the shipments of liquid chlorine from the manufacturers' plants to the water-works. This general order, however, failed to specify the return of the empty cylinders. In consequence, empty cylinders are accumulating in railroad freight houses, in filtration plants and in textile and chemical plants. Thousands of cylinders are scattered all over the country in isolated places. In some cases the railroad agents decline to receive the empty cylinders at all. In others the cylinders are received by the railroad, but are allowed to remain in the freight house. In the meantime, the manufacturers' reserve supply of empty cylinders is practically exhausted, and some cities and industries are working with a short supply of the sterilizing agent.

Cannot Buy More Cylinders

Manufacturers of liquid chlorine would be glad to buy additional supplies of drawn steel cylinders, but they cannot be procured, owing to the pressure of Government business. In fact, the Government recently commandeered a supply of cylinders which the manufacturers had ordered. Various state boards of health have endeavored to have empty liquid chlorine cylinders placed on the same preferential order as the full cylinders. The manufacturers have pointed out to Washington the seriousness of the situation, but so far no results have been attained.

Developments in Philadelphia recently will serve to illustrate the serious condition. Philadelphia ordered a carload shipment of 170 cylinders. The manufacturer started the car out promptly with a rider in charge to see that it got through promptly. That car was a month in reaching its destination.

In the meantime, the city, facing a complete shutdown of its sterilizing system, ordered 30 cylinders shipped by express. These were also sent in charge of a rider. This shipment ran into an express embargo halfway on its journey, and was held up five days at one spot.

Philadelphia Borrows Chlorine

Philadelphia was on the point of being entirely out of chlorine, and the manufacturers borrowed 10 cylinders from a chemical plant that happened to have a small reserve supply. This sufficed until the express and freight shipments finally got through. However, few empty cylinders are being returned to the manufacturers and the situation is becoming critical.

Conditions in Chicago, New York, Kansas City, St. Louis, Buffalo and other cities, large and small, throughout the country, are practically the same. All these cities report difficulties in returning empty cylinders. Before the trouble with the shipments of empties became acute, the manufacturers established warehouses in principal traffic centers, to be stocked with large quantities of full cylinders to be drawn upon by surrounding cities and towns. This method is failing since the refusal of railroads to expedite the return of empties.

Ohio Health Board Protests

A letter from the Ohio State Department of Health, in Columbus, illustrates the liquid chlorine shortage in that state:

"This department is still receiving reports of delayed shipments from time to time from the various municipalities using liquid chlorine. In many cases the delays are quite serious and available supplies are entirely exhausted. You no doubt have numerous complaints on this score.

"Some time ago we suggested to you the advisability of establishing a distributing station at some central point, such as Columbus, to which chlorine could be shipped in carload lots for redistribution to the various points of consumption. We understood from you that this plan had previously been given consideration and that you were endeavoring to effect an arrangement for putting it into practice. We believe that this is the only remedy for the serious delay of shipments by freight in less than carload lots."

Quick Action Urged

The manufacturers receiving this letter replied that they would be glad to establish the warehouse at Columbus, as they had done at other cities, but that the failure to return empty cylinders would nullify its effect and sufficient cylinders were not available to make carload shipments at this time.

The manufacturers are under heavy expense in sending riders with each freight or express shipment. They are unable to make any shipments to chemical or textile plants at this time. The manufacturers are not complaining, but constant complaint is being received from water-works that are not receiving their regular supplies. They simply wish, it is stated, to call the attention of the Railroad Board to their plight and to have the general order expediting chlorine shipments so amended that the railroads' agents will accept it as covering return shipments of empty liquid chlorine containers.

Return Load System Urged

The Chamber of Commerce of the United States is endeavoring, through a circularizing campaign, to promote interest in "return load bureaus" for motor truck transportation. This movement has been developed to a high state of efficiency in Connecticut. A local clearing house is provided in each industrial center to gather and spread information about the movements of trucks and available loads. Incoming trucks without return loads may call at the "return load bureau." Motor truck hauling costs have been cut substantially by this system.

Illinois Forms War Committee

Illinois manufacturers organized for war work at a meeting called by the State Council of Defense at Chicago last week. Two hundred and fifty manufacturers and representatives of trade associations attended the session. A committee was formed which will operate along the same lines as the war organization recently started in Cleveland.

All New Vessels Here Must Be Registered as American

Action has been taken by the War Trade Board, in coöperation with the United States Shipping Board, to insure that all the vessels turned out under the shipbuilding program, or otherwise, shall be registered as American vessels and thereby kept

under the control of the U. S. Government. In order to effect this a ruling has been adopted by the War Trade Board, as follows: "No applications for bunkers by any vessel built in the United States and completed after Feb. 1, 1918, shall be granted, unless the vessel is documented under the American flag, or unless the United States Shipping Board shall have waived such documentation."

New Rules for Marking Express Matter

Important changes in rulings on the marking of express shipments have just been announced by the Express Traffic Assn., to take effect May 1.

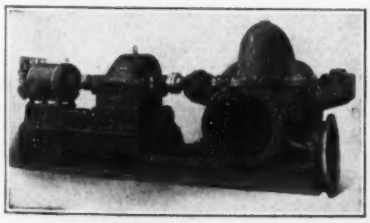
Copies of the rulings, known as Express Classification No. 25, may be obtained from F. G. Airy, agent of the association, 61 Broadway, New York City.

Veteran Superintendent Dies

Richard Ward Baker, aged 68 years, superintendent of outside construction for the Watson-Stillman Co., New York, died Mar. 24 at his home at Roselle, N. J. He spent his entire business life in the services of the Watson-Stillman Co., having entered its employ at the age of 14, finally becoming superintendent, which post he held for many years. Upon the completion of his 50 years service in 1914 the board of directors of the Watson-Stillman Co. celebrated the event by the presentation to him of a substantial check and an engrossed copy of the resolution setting forth the company's appreciation.

An End-Suction Centrifugal Pump

A centrifugal pump with the suction opening directly beneath and parallel to the end bearing has been designed by the Wheeler Condenser and Engineering Co., Carteret, N. J. This arrangement makes it possible to place



a pumping unit in a room of small ground area. In many cases it also facilitates inspection, decreases the length of piping and saves elbows.

The capacity of the particular pump illustrated is 45,000 gal. per minute against a head of 20 ft. The diameter of the outlet pipe is 36 in. The speed is 240 r.p.m., the pump being coupled by a 10 to 1 reduction gear to a steam turbine operating at 2400 r.p.m.

Steel Prices Fixed for Second Quarter

Practically Unchanged, with Large Buying for Ships, Railway Equipment and Government Building in Prospect

Aside from a reduction of $1 a ton in the price of basic pig iron and scrap, steel prices for the second quarter have not been changed by the Government. Steel men are reported to be well satisfied, the only objection reported being that the prices were not fixed for an even longer term. This satisfaction with the present prices takes into account the latest wage increase to employees of the U. S. Steel Corporation, which brings wages up to a point 188 per cent above those paid just 20 years ago. Most of this increase has taken place since 1915.

Mills and blast furnaces are beginning to recover from the lack of transportation, and few furnaces yet remain idle in the Pittsburgh and Youngstown districts, compared to the conditions of February. Their product is being used to the full, and only small lots of structural steel from warehouses appear to be on the market for the public. The shipbuilding program will take a tonnage, if the plans of the Shipping Board work out, greater than the entire fabricating capacity of the country. If 500,000 tons a month of cargo capacity can be built, it is estimated that 250,000 tons of steel, excluding machinery, will be used. Of course, this includes the older yards, which do not draw directly from the bridge shops of the country, as do the three fabricated ship plants; but at the same time, the fabricating capacity of the country up to a year ago was estimated at less than 175,000 tons a month. The huge size of Government construction projects under way is well indicated by recent orders for 15,000 tons of fabricated steel for France, and by two orders for reinforcing bars just placed. One was for 4700 tons of bars for reinforced concrete buildings at Washington, and the other for 3700 tons for one Government storehouse at New York.

A recent survey of the New York building materials market indicates that stocks of brick of all sorts, of gravel, glass, cement and tile are either exhausted, less than half of normal, or entirely taken up for Government requirements. At the beginning of the construction season it is usual to find 700,000,000 Hudson common brick on hand, while the total stock today is estimated at about half this. Cement manufacturers in the Hudson and Lehigh districts are said to have exhausted all stocks, because of the curtailment forced by the freight congestion during the winter. The largest dealers in Mexican grades of asphaltum in the New York market have none to offer and are selling substitutes for road work.

It is reported on good authority at Washington that, the immediate need for rapid construction being over, the program of railway terminal improvements, warehouses, storage depots and other buildings is to be carried out in reinforced-concrete and hollow tile, making structures with low insurance rates and of a more permanent character. This decision, if it has been reached, does not, however, give any promise of slackening the demand for lumber. The ship program, the great amount of timber construction, including housing and perhaps more cantonments, together with the tremendous quantity of form lumber that will be required to carry out the Government's proposed concrete construction, will preclude any slackening at the lumber mills.

As might be expected from these conditions, prices of cement, brick and similar materials show distinct gains over March 1.

Business Notes

The Seitz Auto Co. of Baltimore, Md., is the new distributer for Troy Motor Truck Trailers. The company is offering the entire Troy line to the trade.

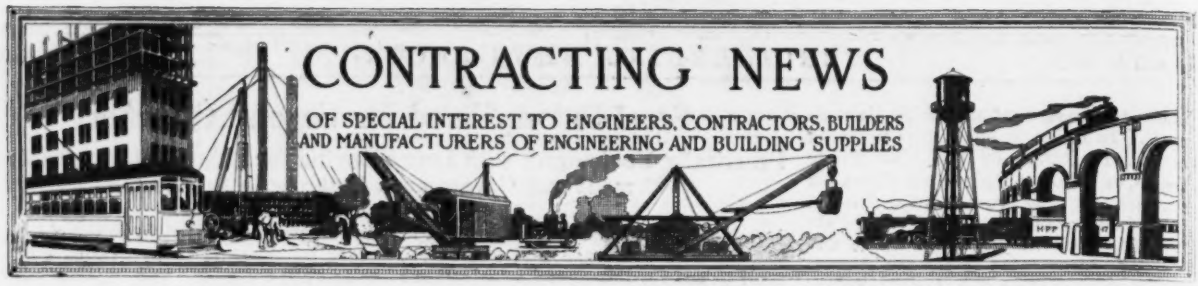
The Easton Car & Construction Co., Easton, Penn., announces the opening of a new branch office in Washington, D. C., at 225 Kellogg Building, 1422 F Street, N. W.

The Louisville Frog & Switch Co., of Louisville, Ky., is successor to the W. M. Mitchell Co. It will manufacture not only railway switches, frogs and crossings, but also the various track devices that have been handled by the old company. W. M. Mitchell is president and C. H. Krauss is general superintendent.

The Westinghouse Electric & Mfg. Co. has leased for a period of years the Baxter Stove Co., Mansfield, Ohio, with the intention of consolidating at this plant the manufacture of its heating appliances now being carried on at some of the other plants of the Westinghouse company.

J. Edward FitzGerald, Inc., dealers and rebuilders of used motor trucks, have removed their New York offices and shops to 91 and 93 West End Avenue.

The Chicago Builders Specialty Co. has organized a new concern under the name of the Equipment Corporation of America, to handle a full line of contractors' second-hand equipment. It has offices in Philadelphia and in the Lumber Exchange Building, Chicago.


CONTRACTING NEWS
OF SPECIAL INTEREST TO ENGINEERS, CONTRACTORS, BUILDERS
AND MANUFACTURERS OF ENGINEERING AND BUILDING SUPPLIES

PIG IRON

Below are the present quotations with a comparison of a month and a year ago.

	Apr. 1, 1918	One Month Ago	One Year Ago
CINCINNATI			
No. 2 Southern foundry	$35.00	$35 00	$32.00
No. 2 Northern foundry	34.26	34.26	37.26
NEW YORK†			
No. 2X Northern foundry	34.25	34.25	40.70
No. 2 plain Northern foundry	33.75	33.75	39.20
No. 2 Southern foundry	38.75	38.75	34.25
BIRMINGHAM			
No. 2 Southern foundry	33.00	33.00	30.00
CHICAGO			
No. 2 Northern foundry	33.00	33.00	38.00
No. 2 Southern foundry	37.00	37.00	....
PITTSBURGH			
Bessemer iron*	37.25	37.25	38.95
Basic iron*	33.95	33.95	35.00

*These prices include the freight charge from the valley to the Pittsburgh district. †Delivered Tidewater, New York.

RAILWAY SUPPLIES

STEEL RAILS—The following quotations are per gross ton f.o.b. Pittsburgh and Chicago for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh		Chicago	
	Apr. 1, 1918	One Year Ago	Apr. 1, 1918	One Year Ago
Standard bessemer rails	65	38.00	65	38.00
Standard openhearth rails	67	40.00	67	40.00
Light rails, 8 to 10 lb.	*3.135 (100 lb.)	58.00	*3.135 (100 lb.)	53.00
Light rails, 12 to 14 lb.	*3.09 (100 lb.)	57.00	*3.09 (100 lb.)	54.00
Light rails, 25 to 45 lb.	*3.00 (100 lb.)	53.00	*3.00 (100 lb.)	52.00

*Government price per 100 lb.

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named:

	Pittsburgh				San Francisco
	Apr. 1, 1918	One Year Ago	Chicago	St. Louis	
Standard railroad spikes, ⅝-in. and larger	$3.90	$3.65	$4.50	$5.30	$6.25
Track bolts	4.90	5.00	5.50	Premium	7.45
Standard section angle bars	3.25	2.35	4.50	Premium	4.90

RAILWAY TIES—For fair size orders, the following prices per tie hold:

	Material	7 In. x 9 in. by 8 Ft. 6 In.	6 In. x 8 In. by 8 Ft.
New York	Yellow Pine	$1.30	$1.11
St. Louis	No. 1 White Oak	.97	.82
Chicago	White Oak—Plain	.95	.71
Chicago	White Oak—Creosoted	1.30	1.15
San Francisco	Douglas Fir—Green	1.35	.96
San Francisco	Douglas Fir—Creosoted	2.44	1.62

PIPE

PIPE—The following discounts are for carload lots f.o.b. Pittsburgh, basing card of Nov. 6 for steel pipe and iron pipe:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
⅛ to 3	51%	37½%	⅛ to 1¼	33%	17%

LAP WELD

2	44%	31½%	1¼	18%	3%
2¼ to 6	47%	34½%	1½	25%	11%
7 to 12	44%	30½%	2	26%	12%
13 and 14	34½%	....	2½ to 6	28%	15%
15	32%	....	7 to 12	25%	12%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛ to 1¼	49%	36½%	⅛ to 1½	33%	18%
2 to 3	50%	37½%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	42%	30½%	1¼	19%	4%
2½ to 4	45%	33½%	1½	25%	11%
4½ to 6	44%	32½%	2	27%	14%
7 to 8	40%	26½%	2½ to 4	29%	17%
9 to 12	35%	21½%	4½ to 6	28%	16%
			7 to 8	20%	8%
			9 to 12	15%	3%

From warehouses at the places named the following discounts hold for steel pipe:

	Black		
	New York	Chicago	St. Louis
⅛ to 3 in. butt welded	38%	42.8%	40.10%
3½ to 6 in. lap welded	18%	38.8%	36.10%

	Galvanized		
	New York	Chicago	St. Louis
⅛ to 3 in. butt welded	22%	27.8%	25.10%
3½ to 6 in. lap welded	List	18.8%	22.10%

Malleable fittings, Class B and C, from New York stock sell at 5 and 5% from list prices. Cast iron, standard sizes, 34 and 5%.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	New York						
	Apr. 1, 1918	1 Month Ago	One Year Ago	Chicago	St. Louis	San Francisco	Dallas
4 in.	$58.35	$58.35	$50.75	$57.55	$57.00	$70.00	$61.00
6 in. and over	55.35	55.35	47.50	54.55	54.00	67.00	58.00

Gas pipe and 16-ft. lengths are $1 per ton extra.

CLAY DRAIN TILE—The following prices are per 1000 lin.ft.:

	New York				
Size, In.	Apr. 4, 1918	One Year Ago	St. Louis	Chicago	San Francisco
3	$35.00	$24.90	$18.40	$15.00	$26.25
4	51.00	33.85	20.70	18.00	34.75
5	65.00	47.00	28.75	23.00	48.75
6	90.00	59.00	40.25	27.00	67.50
8	130.00	100.10	74.75	55.00	....

SEWER PIPE—The following prices are in cents per foot for carload lots:

	New York					
Size, In.	Apr. 4, 1918	One Year Ago	St. Louis	Chicago	San Francisco	Dallas
3	$0.096	$0.087	....	$0.09	$0.075	$0.1032
4	.096	.087	....	.10	.10	.1032
5	.144	.1305	....	.135	.12	.1548
6	.144	.1305	$0.12	.15	.15	.1548
8	.224	.203	.165	.21	.225	.215
10	.336	.3045	.23	.315	.30	.301
12	.432	.3915	.33	.405	.40	.387
15	.576	.522	.50	.54	....	.559
18	.80	.725	.75	.75	.75	.731
20	.96	.87	.90	.90	.962	.86
22	1.28	1.16	1.13	1.20	....	1.1118
24	1.44	1.305	1.28	1.35	1.375	1.29
27	2.145	1.95	1.30	....	....	1.933
30	2.376	2.16	1.70	....	....	2.365
33	3.15	2.88	2.25	....	....	3.01
36	3.5875	3.28	2.50	....	....	3.44

	3	5	8	12	24	36
Boston	$0.102	$0.153	$0.238	$0.459	$1.53	$3.7925
St. Paul	.105	.15	.205	.425	1.59	4.50
Denver	.09	.18	.25	.40	1.35	3.00
Seattle	.09	....	.27	.4875	2.125	....
Kansas City	.10	.135	.18	.36	1.35	3.25
Los Angeles	.0675	.1125	.2025	.36	1.25	....
New Orleans	.0912	.1368	.2128	.684	1.368	3.116
Cincinnati	.10	.14	.22	.42	1.40	3.18
Atlanta	....	....	.28	.47	1.65	....

ROAD AND PAVING MATERIALS

ROAD OILS—Following are prices per gallon in tank cars 8000 gal. minimum f.o.b. place named:

	Apr. 1, 1918	One Month Ago
St. Louis, 45-50% asphalt	$0.08½	$0.07½
Chicago, 15-20% asphalt	.06½	.06½
Chicago, 100% dust layer	.08⅛	.08⅛
Dallas, 40-50% asphalt	.09	.09
Dallas, 60-70% asphalt	.10	.10
Dallas, 75-90% asphalt	.11	.11
San Francisco, 75-95% asphalt	1.90*	1.90*

*Per bbl. of 42 gal.

ASPHALTUM—Price per ton in packages and bulk in carload lots:

	Brand	Package	Bulk
New York	Texaco	....	....
New York	Mexican	....	....
Chicago	Mexican	25.00	21.00
San Francisco	California	15.50	13.50
Dallas	Texaco and Mexican	31.00	29.00
Seattle	D grade	18.00	....
Denver	Trinidad	50.00	....
Denver	California	35.00	....
St. Paul	Trinidad	29.29	....
St. Paul	Bermudas	36.83	....
Atlanta	Texaco	34-35	....
St. Louis	Stanolind	22.50	20.50

*Practically none available in New York.

PAVING STONE—

		Apr. 1, 1918
New York	Manhattan	$2.50 sq.yd.
New York	Other boroughs	2.25 sq.yd.
New York	5-in. granite	2.55 sq.yd.
Chicago	About 4x8x4 dressed	2.25 sq.yd.
Chicago	About 4x8x4 common	1.80 sq.yd.
San Francisco	Basalt block 4x7x8	57.75 per M
Kansas City	Limestone	2.25 sq.yd.
Boston	5-in. granite	2.65 sq.yd.
St. Paul	quotspurg	1.65 sq.yd.
Atlanta	4x4x6-in. granite	1.75 sq.yd.

FLAGGING—

		Apr. 1, 1918
New York	Bronx	$0.17 sq.ft.
New York	Manhattan	.18 sq.ft.
New York	Queens, 5 ft. square	.19 sq.ft.
New York	5x20-in. cross-walk	.30 sq.ft.
Chicago	18 in. wide	.75 lin.ft.

WOOD BLOCK PAVING—Feb. 1

	Size of Block	Treatment	Per Sq.Yd.
New York	3½	16	$2.25
New York	4	16	2.50
Chicago	4	16	1.70
Chicago	3½	16	1.85
Chicago	City specifications		2.10
St. Louis	3½	16	2.02
St Louis	4	16	2.26
Seattle	4	16	1.67
Boston	4	20	2.40
Kansas City	4	16	3.00
St. Paul	Minneapolis specifications		1.78
Dallas	3½	18	2.65
Dallas	4	18	2.78
New Orleans	3½	16	2.30
New Orleans	4	16	2.60
San Francisco	3	16	....
San Francisco	3½	16	....
San Francisco	4	16	....
Atlanta	3	16	1.70
Atlanta	3½	16	1.90